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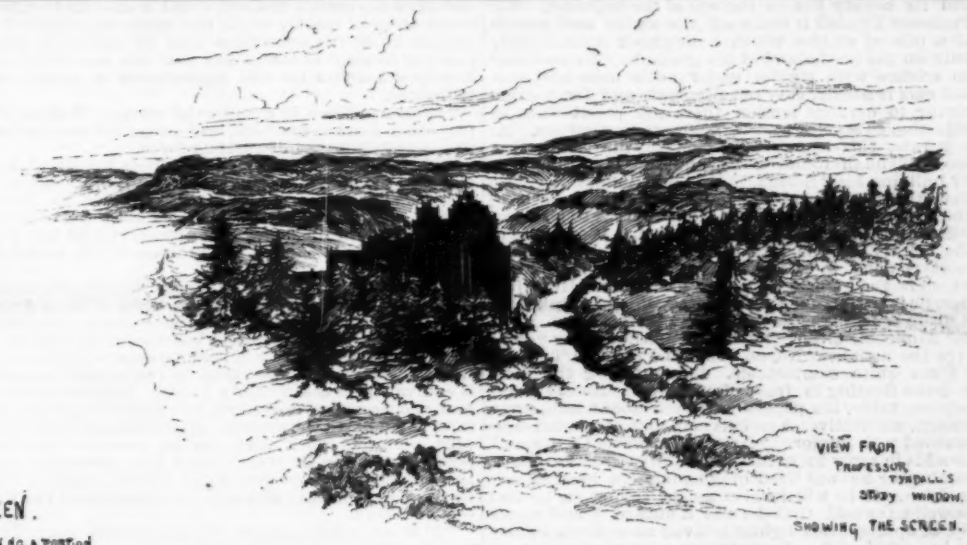
THE SCREEN.
(SHOWING A PORTION OF THE STAIRCASE)



VIEW FROM PROFESSOR TYNDALL'S STUDY WINDOW.
SHOWING THE SCREEN.

PROFESSOR TYNDALL AT HOME.

To spend a sunny autumn afternoon on Hind Head with Professor Tyndall is a privilege more valuable because necessarily rare. Sunny days have become hard to find, and the professor himself is not usually to be discovered in England at the time of year, but descends from the mountains of Switzerland to the comparative lowlands of Haslemere only with the winter. Hardly since Professor Tyndall and Mrs. Tyndall came to their present belief that in England there is no place like Hind Head, have they seen the heather purple with the autumn on the Surrey hills; for during many years their summers and autumns have been passed in their chalet on the Bel Alp, and only winter has persuaded them to say "Au revoir" to the great Aletsch Glacier. If anything, however, could make up for the loss of the annual visit to Switzerland, a loss which illness has occasioned, an English autumn of days such as that on which Professor Tyndall sat for his latest portrait would be as adequate a compensation as any. The valleys were flooded with light, and unstirred by a breath of air, but on the hill was a vivifying freshness of atmosphere. On the rippling ranges of hills to south and west a misty blue gave to their massed contours some likeness to the sea, which on a clearer day may with the eye of faith be seen beyond them. A point of light on one of them reminds our host that Lord Tennyson is a neighbor who could easily be signaled by heliograph. The garden of Hind Head House is of a piece with its surroundings, for it is all heather except for a little budding plantation where it dips down the hill. Past it the road, white with dust or yellow brown with rain, twists and descends through a purple land of heather.

And this is the view, with its changes of hour and season, upon which the study looks. It has many changes. "One day this last August," says Professor Tyndall, "the valley below was spanned by a rainbow. It was very vivid and beautiful, and had four or five supernumerary bows. But I think at evening the view is most striking, for then the sun strikes across those distant hills, throwing their valleys into shadow, and lighting clearly on the summits. That's a remarkable escarpment possessed by that hill to the left—is it not?" The study is one of those cozy little places littered with books and papers and chairs, which seem more fitting to one's own tastes and wishes in the matter of studies rather than to the production of scientific treatises and Nineteenth Century essays (a phrase of double meaning). There are certain volumes of Philosophical Transactions which few of us would be bold enough to choose for ordinary companionship; but a file of the *Times* and some volumes of the "Dictionary of National Biography" are suggestive of reading which, even if it may not be called light, is not beyond our sympathies. There is also a large volume of Milton; but I am reluctant to draw conclusions from premises so incomplete as its mere presence. One has generally a vague expectation of finding scientific instruments, electric batteries, and the like about the room; but this is an expectation not gratified, for the study is for theory, not for practice, and the only tools to be found are those of a humble science—joinery and carpentry. They hang in an appalling row, suggestive rather of savage warfare, and are characteristic of their owner and workman. "I am by nature a savage," he says, "and so is Mrs. Tyndall. [The writer does not hold himself responsible for this libelous allegation.] That is why we chose Hind Head. Years before this house was built we used to live in a little hut among the heather and do our own cooking, living entirely by ourselves. Mrs. Tyndall was the architect of this house, and we built it as the birds build, so that we might live entirely in its higher stories, and the lower part of it be only a pedestal."

I can only repeat that I do not hold myself personally responsible for everything Professor Tyndall says. If the ground floor is only a pedestal, it is at least an unusually comfortable contrivance.

"I think we like it pretty nearly as well as the hut," he continues, "but when we were building it I remember Lord Tollemache, my wife's uncle, saying to me, 'What are you going to do with that house, Tyndall?' 'Well,' I said, 'I was thinking of living in it.' 'Ah,' he said, 'you'll never be so happy as you were in the hut.'"

I really think that if it were not that illness has kept him in the house all the spring and summer, Professor Tyndall would have camped out in the garden. He is very fond of this heather garden, which is in some respects

PROFESSOR TYNDALL AT HOME.

his laboratory. At the lower end of it is the very much abused screen, built of heather and pine. On the screen depend some of the few outward and visible signs of scientific inquiry which Hind Head House discovers—instruments for atmospheric observation; and Professor Tyndall is indebted to the structure for many interesting experiments—I may add for other things also.

"You have heard," he said, "of the saying of Wordsworth—of how he used to walk about his garden booing his poetry. Well, I like to walk round my garden booing my science, and meditating. My screen helps me to do this secure from observation.'

To speak of Hind Head House and its demesnes without reference to the "Screen" were an unnecessary affectation. This tall structure is too striking an object to be ignored. It is a light scaffolding of pine poles, the interstices of the cross-work filled with heather, blackened by two winters. It faces south, and its beauty lies in the eye of the beholder. For Professor Tyndall it shuts off the sights and sounds of a pile of stables which a neighbor thoughtfully built on the borderland of his grounds. To meditate on science with stables under one's nose and eyes and ears is neither easy nor pleasant, and for a mind strung to nervous tension there are possibilities of objection to stables seen through study windows. At any rate, this is not to overstate the case. Professor Tyndall found a way out of his difficulties by building his "Screen." He finds it more tolerable than the stables and chimneys which it shuts out; and that, it seems to me, is all that there is to be said.

Since his illness some of his work has been done in the library, on the same floor as his bedroom. But most is done in the sun-warmed balconied study, which is the highest room in the house. Here it is that he is sitting for the portrait, which I think I am right in speaking of as the latest taken of him. He is an admirable sitter. "I hope I am not tiring you?" says the artist. "No, no," replies Professor Tyndall, "I am quite comfortable. I'm watching the little globules floating in front of my eyes." He sits at his writing table, his papers scattered about him, gray, Scotch, meditative. A serious man, but of a seriousness touched with humor. "Nay, I'm a stiff-necked man," he adds in reply to a further inquiry by the artist as to whether he was tired of keeping his head in one position. If he will forgive me for saying so, he had as well have said that he was a man of a stiff upper lip, of opinions not lightly arrived at and not lightly to be parted with. A charming conversationalist, he speaks of many subjects. Of woman's suffrage, which he does not favor—a statement which impresses me the more since he makes it in the presence of Mrs. Tyndall; of Rudyard Kipling, for whose work he has a great admiration; of the principle of Irish separation, on which his views are already public property. He tells an anecdote of Carlyle, whose views on the subject were scarcely less decided. "Maun!" said Carlyle, "d'ye think we want our house divided into two; and the back parlor full of French socialists and American delegates?" And he talks of his own work with that large affection which, for most of us, is only vaguely comprehensible. It is forty years now since, a student at Marburg, he used to begin the day when the chimes of the church of Saint Elizabeth of Hungary struck six, and do sixteen hours of work before that day closed. He attended the lectures of Bunsen in the laboratories there, and afterward at Berlin he worked under Stegmann, Magnus, Riess, Wiedemann, and Helmholtz. He has worked and experimented and lectured and taught. His accumulated knowledge has made the world wiser, has advanced the world's well being. After a life of work there remains to him now a task which must be fulfilled—that of making complete the unfinished record of that work.

"It will take me five years," he says, "five years to finish it; but finish it I will. And when I've done my work—well, then——"

Well, then, I think, Professor Tyndall might even be persuaded to take down his screen.—*London Daily Graphic.*

INTELLIGENT ATOMS.

"My mind is not of a speculative order," said Mr. Edison; "it is essentially practical, and when I am making an experiment I think only of getting something useful, of making electricity perform work.

"I don't soar; I keep down pretty close to earth. Of course there are problems in life I can't help thinking about, but I don't try to study them out. It is necessary that they should be studied, and men fitted for that work are doing it. I am not fitted for it. I leave the theoretical study of electricity to the physicists, confining my work to the practical application of the force. It is my belief, however, that every atom of matter is intelligent, deriving energy from the primordial germ. The intelligence of man is, I take it, the sum of the intelligences of the atoms of which he is composed. Every atom has an intelligent power of selection and is always striving to get into harmonious relation with other atoms. The human body, I think, is maintained in its integrity by the intelligent persistence of its atoms, or rather by an agreement between the atoms so to persist. When the harmonious adjustment is destroyed the man dies, and the atoms seek other relations.

"I cannot regard the odor of decay but as the result of the efforts of the atoms to dissociate themselves; they want to get away and make new combinations. Man, therefore, may be regarded in some sort as a microcosm of atoms agreeing to constitute his life as long as order and discipline can be maintained. But of course, there is disaffection, rebellion and anarchy, leading eventually to death, and through death to new forms of life. For life I regard as indestructible. That is, if matter is indestructible.

"All matter lives and everything that lives possesses intelligence. Consider growing corn, for example. An atom of oxygen comes flying along the air. It seeks combination with other atoms and goes to the corn, not by chance, but by intention. It is seized by other atoms that need oxygen and is packed away in the corn where it can do its work. Now carbon, hydrogen and oxygen enter into the composition of every organic substance in one form of arrangement or another. The formula CHO, in fact, is almost universal.

"Very well, then why does a free atom of carbon select any particular one out of fifty thousand or more possible positions unless it wants to? I cannot see how we can deny intelligence to this act of volition on the part of the atom. To say that one atom has an affinity for another is simply to use a big word. The atom is conscious if man is conscious, is intelligent if man is intelligent, exercises will power if man does, is, in its own little way, all that man is. We are told by geologists that in the earliest periods no form of life could exist on the earth.

"How do they know that? A crystal is devoid of this vital principle they say, and yet certain kinds of atoms invariably arrange themselves in a particular way to form a crystal. They did that in geological periods antedating the appearance of any form of life and have been doing it ever since in precisely the same way. Some crystals form in branches like a fern. Why is there not life in the growth of a crystal? Was the vital principle specially created at some particular period of the earth's history, or did it exist and control every atom of matter when the earth was molten? I cannot avoid the conclusion that all matter is composed of intelligent atoms and that life and mind are merely synonyms for the aggregation of atomic intelligence.

"Of course there is a source of energy. Nature is a perpetual motion machine, and perpetual motion implies a sustaining and impelling force.

"When I was in Berlin I met Du Bois Reymond, and wagging the end of my finger, I said to him, 'What is that? What moves that finger?' He said he didn't know; that investigators have for twenty-five years been trying to find out. If anybody could tell him what wagged this finger, the problem of life would be solved.

"There are many forms of energy resulting from the combustion of coal under a boiler. Some of these forms we know something about in a practical way, but there may be many others we don't know anything about.

"Perhaps electricity will itself be superseded in time, who knows? Now a beefsteak in the human stomach is equivalent to coal under a boiler. By oxidization it excites energy that does work, but what form of energy is it? It is not steam pressure. It acts through the nerve cells, performs work that can be measured in foot pounds, and can be transformed into electricity, but the actual nature of this force which produces this work—which makes effectual the mandate of the will—is unknown.

"It is not magnetism, it doesn't attract iron. It is not electricity—at least not such a form of electricity as we are familiar with. Still, here it is necessary to be guarded, because so many different forms of electricity are known to science that it would be rash to say positively that we shall not classify vital energy as a form of electrical energy. We cannot argue anything from difference in speed. Nerve force may travel as fast as electricity, once it gets started. The apparent slowness may be in the brain. It may take an appreciable time for the brain to set the force going.

"I made an experiment with a frog's leg that indicates something of the kind. I took a leg that was susceptible to galvanic current. The vibration produced a note as high as a piccolo. While the leg was alive it responded to the electrical current: when it was dead it would not respond. After the frog's leg had been lying in the laboratory three days I couldn't make it squeal. The experiment was conclusive as to this point: The vital force in the nerves of the leg was capable of acting with speed enough to induce the vibration of the diaphragm necessary to produce sound.

"Certainly this rate of speed is much greater than physiologists appear to allow, and it seems reasonable that there is a close affinity between vital energy and electricity. I do not say they are identical; on the contrary, I say they are very like. If one could learn to make vital energy directly without fuel, that is without beefsteak in the stomach and in such manner that the human system could appropriate it, the elixir of life would no longer be a dream of alchemy. But we have not yet learned to make electricity directly, without the aid of fuel and steam.

"I believe this possible; indeed, I have been experimenting in this direction for some time past. But until we can learn to make electricity, like nature, out of disturbed air, I am afraid the more delicate task of manufacturing vital energy so that it can be bottled and sold at the family grocery store will have to be deferred.

"Electricity, by the way, is properly merely a form of energy and not a fluid. As for the ether which speculative science supposes to exist, I don't know anything about it. Nobody has discovered anything of the kind. In order to make their theories hold together they have, it seems to me, created the ether. But the ether imagined by them is unthinkable to me. I don't say I disagree with them, because I don't pretend to have any theories of that kind and am not competent to dispute with speculative scientists. All I can say is, my mind is unable to accept the theory. The ether, they say, is as rigid as steel and as soft as butter. I can't catch on to that idea.

"I believe that there are only two things in the universe—matter and energy. Matter I can understand to be intelligent, for man himself I regard as so much matter. Energy I know can take various forms and manifest itself in different ways. I can understand also that it works not only upon but through matter. What this matter is, what this energy is, I do not know.

"However, it is possible that it is simply matter and energy, and that any desire to know too much about the whole question should be diagnosed as a disease; such a disease as German doctors are said to have discovered among the students of their universities—the disease of asking questions."

OTHER VIEWS.

Dr. James H. Hyslop, professor of philosophy, ethics and psychology in Columbia College, says:

"I have no theory of my own upon the subject of life. However, this I should say, Mr. Edison's views are not without the warrant of philosophy.

"The great German philosopher Loetze, for instance, holds that all atoms are conscious and of a spiritual nature. In this way he undertakes to account for the soul. What we call soul is, according to his theory, only a dominant atom. This view is reconcilable with the laws of evolution on the hypothesis that the strongest atoms survive, or more correctly, perhaps, that they control the weaker atoms. The difficulty, of course, arises when we begin to select words with which to express so abstract an idea as life. Whatever form of expression is adopted, it is not likely to mean the same thing to all men.

"An atom, we understand, occupies some space. But is not the first principle immeasurably illimitable? But anything that occupies space cannot be the first principle. Loetze, holding that the so-called facts of life can be explained by mechanical forces, eliminates the term life or vital force and believes only in soul. Loetze must believe that the soul can come into mechancial relations. This consciousness of atoms he extends resolutely to all material objects, even to crystals. However, the atoms, he contends, have no distinct existence, but are all purely dependent upon the soul, which is God."

Dr. William Thompson, professor of physiology in the University of the City of New York, says: All the analogies of physiology are quite consistent with Mr. Edison's views. The time it takes to send a message from the brain to the muscle which is to work has been measured. Therefore we own we have some definite nerve force with which to draw. What that nerve force is we do not know. We know what it is not. It is not chemical; it is not magnetic. There is much that is very suggestive with regard to Mr. Edison's proposition that all matter is conscious. Man we know is not a simple organism. He indulges in what physiologists call "conscious and subconscious cerebration." We are pleased to call this subconscious cerebration automatic. But although our higher consciousness is unaware of what our lower consciousness is doing, this does not alter the fact that the latter may be just as conscious as the former, although a wall keeps the two centers of volition from exchanging confidences.

If, then, we admit this much, the hypothesis that each individual protoplasm and each individual atom contributing that protoplasm is conscious is certainly quite reasonable, although from the point of view of physiology there is no life properly so called without protoplasm.

Professor T. Sterry Hunt, mineralogist and mine engineer, says:

Mr. Edison's hypothesis has nothing to fear from the physicist. Crystals certainly live. When it is considered that it is demonstrated that these stone plants are affected by light, it can be realized that they are not so insensible as popularly supposed. The life of crystals is a different kind of life than that of plants, but, if I understand the term, they live in their own way quite as decidedly as do plants and animals.

Francis Hovey Stoddard, professor of literature in the University of the City of New York, disclaiming any special knowledge in the physiological aspect of life, sees the problem pretty well worked out in the world of literature.

The mainspring of life, says Professor Stoddard, is desire, and the ceasing of desire is the signal for death. The old distinction between man and beast turns upon this: The desires of the beast are constant; those of man are progressive. The animal desires the same thing to-day it desired yesterday; man more to-day than he desired yesterday, and more life will only come with more desire.

It is true, as Herbert Spencer suggests, a proper environment is one of the conditions of more life, but the proper desire to live will prompt man to more intelligently take this environment into account. In many men the desire to live is feeble. In most of them it is not half so intense as it might be, and this is because the interest in life is not what it should be. Man's ideals created in literature, art and society are not sufficiently satisfying, do not properly appeal to his imagination—are not, in a word, adequately progressive. Increase the interest in life and ever keep on increasing it, and you increase life's sum total.

Walter L. Hervey, dean of the School of Pedagogy, of the University of the City of New York, says:

Between the conditions of physical and mental life there exist these analogies: Appetite in the one corresponds to interest in the other.

"We can well afford to devote half our time to creating an interest," says Horace Mann, "and the other half to satisfying it." Indeed, if civilization had not largely done this for us, we would be at the zero point of existence. For without at least some interest in life there can be no life. Anything that increases this interest of life increases life itself.

Mrs. Anna Besant puts forward the explanation of theosophy, and says:

The whole universe is a manifestation of central life which is present in every atom of matter. What we speak of as a thing living or dead is simply arrangements of matter which vary the manifestations of life. Even in a biological sense death involves new life. Doctors may be able to settle that any given body is dead quite to the satisfaction of a coroner's jury, but they don't even profess to know anything about the soul, and this is well. I am afraid their determinations would not be satisfactory to everybody. No; I cannot concede that there is one absolute principle; at least this is not conceivable. There can be no life without love; no love without a positive and negative—in fact, no thought or consciousness without this antithesis, this contrast, this comparison.

Besides, if science and philosophy will talk of an absolute principle, why not have two absolute principles? It is just as easy or as hard; you can take your choice.

William M. Chase, as the exponent of art, selects a word slightly different from those used by the other thinkers.

Life is impulse, says the president of the American artists. A truly artistic life does not depend upon environment. We have had art under all sorts of conditions and in every kind of environment. Of course, an artist must have his schooling, but this alone does not constitute the artistic life. This depends upon the mental state of the artist, and the accomplishment of an artistic result must spring from activity, this activity again from an impulse. The vital principle of this impulse no one can analyze. The artist alone feels it, knows it, finds in it his inspiration and success. The true artist can say this much of a life—he is satisfied with it. His means of expression are so varied, so full, so complete; his energies are so delightfully

occupied with all a world of light, color, atmosphere, form and sentiment that he is content. Content to live because it is delightful to live—content to die because he has lived indeed.

Lillie Devereaux Blake, president of the New York City Woman's Suffrage League, says:

Life to the student of psychology or physiology is a mystery deep and impenetrable. Life to you or me is what we make it. Life is love in all its relations—love of home, children and humanity.

Colonel Robert J. Ingersoll says:

Life is something I know nothing about. It is something that no one knows anything about except the ministers. They know all about it; the other smart men gave it up long ago.

The theological point of view, represented by Dr. R. Heber Newton, runs along parallel lines with Mr. Edison. Does the rector of All Souls' church profess to solve the question? Oh, no. He declares it unsolved and, as it appears to him, unsolvable.

We have not, says he, even a hint from anything around us in the past or future that will help us to the solution. The greatest scientific men of to-day who might be expected to assist us only confuse us the more.

All our roads lead out into mysteries. Science, so far from exhausting this mystery, has only deepened, broadened and heightened it. I will not deny that we have had a vast light shed upon the problem of life. But I do say that when we have all this light we still have a larger and denser circumference of darkness. In fact, the more you study the question, the more of a mystery it becomes.

I have watched through a microscope the blood corpuscles circulating through the fins of a fish, and been filled with wonder at the thought of how life commenced and ceased. Tiny cells of life, if you please, yet each cell carrying in itself the substance of all that is law, order and existence.

If we knew what is life, then would we know all things. However, this much is to be said: Wherever life is, there is God. That at least is the poetic view of the question, if we can believe Lord Tennyson:

> Flower in the crannied wall:
> I pluck you out of the crannies;
> Hold you here, root and all in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is.

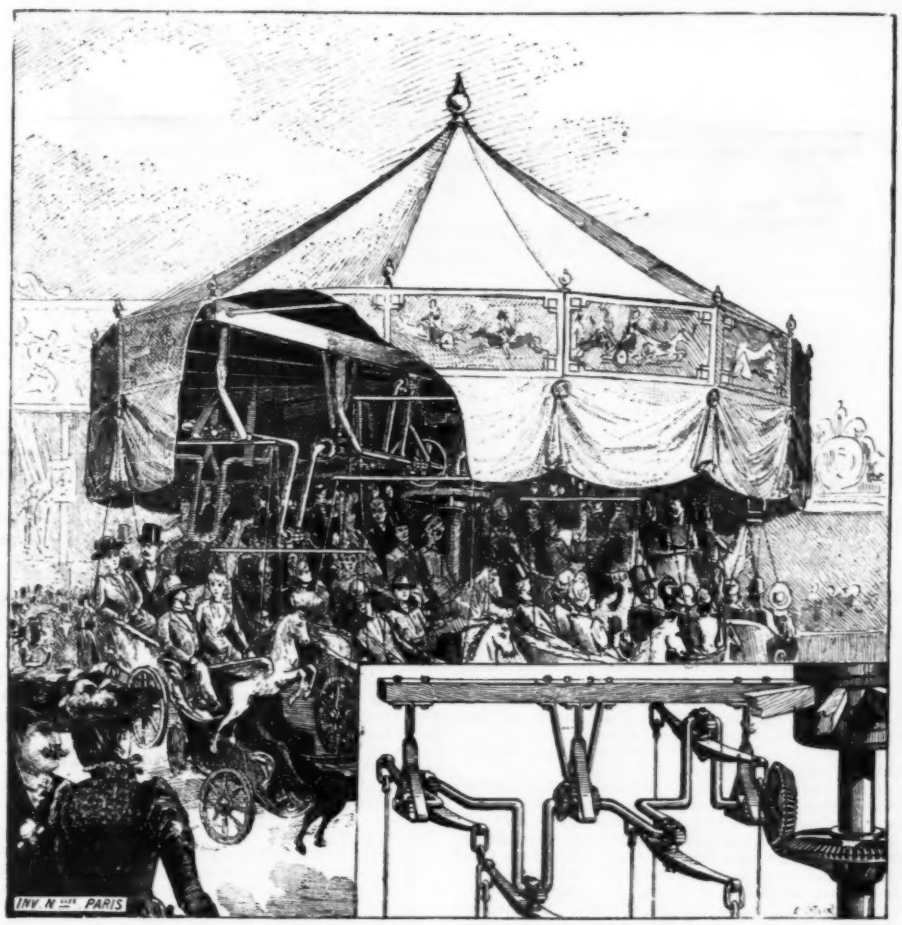
NOT PRACTICAL.

The theory of the English scientist, Clodd, that death is not a necessary event, is, it seems to me, not promising or practical. There is a certain natural limit to the life of all organized beings. A tree springs up, withers and dies; an animal is born and in course of time passes away. Such by analogy, it seems to me, must be the case with man. He may be able to live a greater number of years than he does at present; but that number, I think, will not be greatly extended, and he must eventually die. In fact, I don't see anything around me to show that at the present day, with all our advanced medical knowledge, we are living to any greater age than did our forefathers.

If men were to live forever the world would soon be full, but I don't think that their condition would be improved. It would certainly not make an earthly paradise of the world—at least for those who come into it. The struggle for existence is hard enough already without having any more competitors.—*New York Herald.*

MERRY-GO-ROUND.

OF all the apparatus constituting the ordinary material of fairs, the one that has undergone the most improvement during the last few years is undoubtedly the merry-go-round. The two-story apparatus, actuated first by a horse and afterward by a steam motor, have gradually replaced the antique affair moved by a winch. To-day such improvements appear insufficient, and they have been completed by various additions, especially by tables revolving around a vertical axis which itself participates in the rotary motion of the merry-go-round, and by the substitution of rocking horses for fixed ones, etc. Our engraving shows a still more complicated arrangement, and which is likely to meet with great success. The carriages, which are placed according to a same radius, are suspended from a cranked shaft formed of two sections connected by a bevel gearing and each carrying two cranks of opposite direction. It follows, in the first place, that carriages 1 and 3 will rise, while 2 and 4 will descend, and inversely; but, moreover, by reason of the motion in contrary direction of the two sections of the shaft, the carriages 1 and 2 will turn in a direction from right to left, for example, while the two others will move in the opposite direction. As the whole is carried along in the general rotary motion of the merry-go-round, it will be seen that the *ensemble* will produce a most curious effect, not only for the persons participating in the motions, but also for those who are simply spectators.—*Les Inventions Nouvelles.*



IMPROVED MERRY-GO-ROUND.

OUR SOURCES OF TIN.

By GEORGE P. MERRILL.

THE world's supply of tin amounts to some fifty thousand and odd tons annually, of which nearly one-half comes from the Malayan Peninsula and the adjacent islands, one-sixth from Cornwall, England, one-ninth from Australia, and the remainder from scattering sources, including Saxony and Bohemia, Finland, Spain, Tasmania, Bolivia and Mexico. The United States has, until very recently, produced but little.

The artificial condition of the tin market, due to the passage of the McKinley bill, has awakened an interest in our possible sources of supply, and it may be worth our while to occupy the columns of *Stone* with a brief review of the same.

At the outset it may be well to state that tin stands unique among our common metals, in that it is derived wholly from one type of ore, cassiterite, an oxide of the composition SnO_2, which is equivalent to tin 78·6 per cent. and oxygen 21·4 per cent. To fully appreciate this peculiarity of the metal, we have but to recall the fact that gold occurs and is mined as native, in at least three sulphurets, and as a telluride; silver as native in two sulphurets, two sulphantimonides, an arsenide, telluride and chloride; copper as native, in the form of three sulphides, a sulphantimonide, sulpharsenide, oxide, carbonate, and silicate; lead as a sulphide, sulphate and carbonate, iron in the form of three oxides, and as carbonate; and zinc as an oxide, silicate, carbonate and sulphide. Indeed, aside from cassiterite there is known but one natural compound in which tin plays a prominent part—this is the sulphide of tin, *stannite*, which however is rare even as a mineral.

Tin is pre-eminently an old metal, that is, found *in situ* only in the older rocks. Its occurrence in more recent deposits, or alluvial formations, is due to the decomposition of these older rocks and the accumulation of the tin as gravel.

According to Whitney the ore deposits of this metal occur in four principal forms. These are (first) in flat sheets or beds lying between the laminæ of the schists and granites and parallel with one another. Each such deposit is usually quite limited. Such are called floors by the Cornish miners. The second form is the so-called stock work, in which the ore is concentrated in innumerable small veins ramifying through the rock. The third form of occurrence is in true fissure veins, and the fourth in alluvial deposits, which yield the so-called stream tin. This last form is wholly secondary and the ore may have been derived from any one or all of the others mentioned.

There is still a fifth form closely allied to the stock work deposits, but which is of sufficient importance to merit especial attention. In these deposits the cassiterite is found impregnating for varying distances the wall rock adjacent to the true veins, as at the East Huel Lovell mines in Cornwall, or again disseminated throughout the rock apparently quite independently of or but remotely connected with veins, as at some of the Saxon mines, or as is illustrated in a more striking manner in the so-called carbonas of the St. Ives Consuls, also in Cornwall. Such are known as impregnations.

The first promising discovery of tin in America was made at Jackson, New Hampshire, in 1840. A bar of tin smelted from this ore has been for many years among the collections of the National Museum. Another deposit at Winslow, Maine, was at one time regarded as promising, and which attracted considerable attention. The veins, however, were seldom more than an inch in thickness and occurred interlaminated with the rock, the veinstone consisting of purple fluorspar, silvery white mica, and quartz. In the gangue the cassiterite is associated with mispickel.

Tin-bearing areas of greater promise occur along the line of the Appalachians farther to the southwest. According to Arthur Winslow, now State Geologist of Missouri, a tin-bearing area in Virginia "extends along the east edge of Rockbridge County, in the line of the Blue Ridge Mountains, from a few miles north of the James River Gap to about the north line of the county." Throughout this area cassiterite has been found at many points, but that of most promise at the time of writing was considered to be along the upper waters of Irish Creek. The country rock is a coarse hornblendic granite intersected by trap dikes, and traversed by numerous fissure veins of quartz, or quartz, iron pyrites and mica, nearly all of which show more or less tin ore. The veins are mostly small, rarely more than a foot or so in width, and the cassiterite occurs in disseminated crystals, nodules and strings. The average yield of tin is, however, low, varying from 0·63 per cent. to 1·12 per cent.

Occasionally the tin stone occurs as a solid veinlet an inch or more in thickness, and mention is made of a nodule found about six feet below the surface nearly a foot in diameter and which consisted of nearly pure cassiterite. The national collections contain a block of ore from the Cash mine in this vicinity which shows a solid mass of cassiterite some 3 to 5 inches in diameter and weighing together with the attached gangue some 76½ pounds.

Tin ore has been found in considerable quantity in the eastern suburb of King's Mountain, Cleveland County, North Carolina. A good deal of prospecting has been done and shafts sunk to the depth of 30 feet. In no place has the deposit, either of drift or vein, been found sufficiently rich to pay for working. The ore here occurs not in greisen, but in quartz veins, and it is stated only in the vicinity of trap dikes.

Cassiterite in quantities sufficient to seemingly warrant the erection of dressing and smelting works occurs in lodes and disseminated in gneiss some two miles southeast of Ashland, Clay County, Alabama. The so-called Broad Arrow mines were located at this point. In 1883 it was stated the mines thus far developed consisted of four open quarries some 30 to 55 feet in depth, the country rock being mica schist interlaminated with six seams of ore-bearing gneiss, which, however, averaged only some 1½ per cent. of ore. These mines apparently proved unprofitable, as they are no longer in operation. Tin ore is also found at Rockford, Coosa County, in same State.

For many years reports have been current of extensive tin fields in the region of the Black Hills of Dakota.

According to Prof. W. P. Blake there are three well-defined districts of tin-bearing lodes in that region. These are:

(1.) On the east side of the Harney range, at the Etta, Ingersoll, Monarch, Peerless and other claims.

(2.) Near the summit, at Bismarck's ranch, where cassiterite occurs in several narrow veins of quartz.

(3.) At Hill City, on the western side of the Harney range, where it occurs in both granitic veins and quartz veins.

There is also a tin district in the Wyoming portion of the Black Hills, about twenty miles west of Deadwood, where stream tin has been found and tin-bearing granitic veins are also reported as occurring. The gangue rock at these localities is either mainly quartz, as at Hill City, or more commonly an aggregate of white mica and quartz, together with some albite. With these minerals is commonly associated spodumene, often in crystals of enormous size, and more rarely apatite, tantalite, a small quantity of vitreous copper, and a few other minerals.

The cassiterite is regarded by Professor Blake as originating contemporaneously with the rock in which it occurs. The veins themselves show no indications of having been formed by gradual deposition from lateral solution, but are evidently the result of the gradual cooling of semi-fluid or pasty magmas intruded from below.

The country rock is fine-grained arenaceous slate and quartzite. The mineralization of the ore is stated by Professor Blake to be remarkably even, the greisen rock yielding from 2½ per cent. to 6 per cent. ore, while the general average percentage of six large mines upon the great flat lode of Redruth, Cornwall, in 1876, was but 2·22 per cent., and less than this has been worked with profit in some places.

A large amount of money has recently been invested here, principally by English capitalists, and concentrating plants and smelting furnaces are stated to be

in process of erection. It is not at all improbable that this may shortly prove an important source of supply.

The national collections show promising samples of stream tin from Ten Miles district in Lewis and Clark county, and Prickly Pear, Jefferson county, Montana. No systematic mining is, however, carried on at either locality.

Still another tin field which as yet has yielded little but promises, occurs in San Bernardino county, California. This is the now well-known Temescal or San Jacinto field.

According to a writer in the *Engineering and Mining Journal*, the country rock at the San Jacinto mines is "syenitic granite, syenite and slate," cut at various places by veins of porphyry and quartzite. The veins of ore are of a coal black color, varying from 18 inches to 60 in width, and vary in direction from north and south to east and west. Within a distance of three and one-half miles in an east and westerly direction were found upward of seventy croppings, representing, apparently, as many different veins. Comparatively little has as yet been done here in the way of developing the mines, the most substantial development being upon what is known as the "Cajalco Lode." This vein in its entirety averages some six feet in thickness, though the cassiterite bearing or "pay streak" is not over two feet wide. It was estimated that there were here some 2,700 tons of ore in sight which would yield about 4 per cent. tin. The general character of the ores is, however, such that they are expected to improve in depth.

This property has also recently passed into the hands of an English syndicate. It comprises some 45,000 acres or seventy square miles, and is situated in San Bernardino county, within 10 miles of Riverside and some fifty-five miles east of Los Angeles. Smelting furnaces have been erected, and already a shipment of seven tons of pig tin has been exported. A large pig made from the Temescal ore was exhibited at the Centennial Exposition at Philadelphia in 1876, and was thence transported to the National Museum at Washington, where it still remains.

The industrial journals have recently chronicled the discovery of rich tin lodes in Mexico, about forty-five miles south of Durango. This is evidently a rediscovery of an old locality, since tin ores from this or adjacent regions were reported many years ago. It is difficult, in the present condition of the industry, to say how much reliance can be placed upon such accounts as are given of this deposit. As long ago as the time of Humboldt cassiterite was obtained from washings in the province of Guanaxnato and in the state of Zacatecas, and in 1803, according to Whitney, some 581½ quintals of tin were exported.

Tin ore is also included among the mineral productions of Bolivia, South America, although the deposits, according to the latest available information, are not worked to any extent, owing, presumably, to difficulties in the way of transportation. The localities given are Potosi and Oruro.

Below are given the best available statistics regarding the world's output in metallic tin for the year 1888:

Great Britain	9,241	tons.
The Malay Peninsula and adjacent islands	27,990	"
Australia	6,559	"
All other sources	12,710	"
Total	56,500	tons.

The above, it is believed, includes all the known sources of tin at all important or promising within the limits of the United States. Those which seem at present as likely to assume a prominent part in the world's supply are Dakota and California. That there is here tin in quantities fully equal to that mined in other countries there is little doubt, and were the American content or obliged to work at the wages given the Chinese coolie or even the Cornish miner, there is apparently but little doubt of their becoming permanent sources of supply. What will be the outcome of existing conditions it is as yet too early to say, although it is seemingly apparent that within a few years the United States will not merely manufacture her own tin plate, but produce a considerable share of the metal used as well.—*Stone.*

THE LAST DAYS OF THE GREAT EASTERN.

BY the kindness of Messrs. H. & C. Grayson, shipbuilders and engineers, of Liverpool, we are able to give some interesting views of the various stages in the process of breaking up the great leviathan.

The Great Eastern was built in the years 1853–59 by Mr. Scott Russell at Millwall, in the Isle of Dogs, from the designs of Mr. Isambard Brunel. Previous to 1851 the only routes to India were the overland one, which was very expensive, and by sailing vessels *via* the Cape of Good Hope, which was a long and tedious voyage. In that year the idea of running steamers to India *via* the Cape was put in force, but did not prove successful, owing principally to the expense of maintaining coal depots at various stations *en route*. This failure led to the idea of building a steamer large enough to carry sufficient coal for the voyage out and home, and Brunel was intrusted with the solution of this problem. For this purpose he designed a vessel 680 ft. long, 83 ft. broad, 114 ft. broad over the paddle boxes, 58 ft. moulded depth, and 18,915 tons gross register, to be propelled with both screw and paddles, and with a combined nominal horse power of 3,000. These were the smallest dimensions which he considered would suffice for the purpose, the main object of which was to obviate the necessity of stopping to coal on the way, which had caused a delay of twelve to twenty days to those steamers which had previously made the voyage, and also to avoid the greatly increased cost of coal supplied in this manner, as coal which could be purchased in England for 12s. to 14s. per ton would at the Cape and Australia cost from £2 10s. to £5 per ton. In 1853 Mr. Scott Russell got the order to build the ship, and also began the construction of the monster steam paddle engines, with four cylinders 14 ft. stroke and 74 in. diameter, while Messrs. Watt commenced the screw engines with four cylinders 84 in. diameter and 4 ft. stroke. This in 1853 was no mean undertaking, involving a weight of ship and engines, when completed, of between 12,000 and 13,000 tons. Misfortunes early attended her in the process of construction, and it was not till the 3d of November, 1857, that an attempt was made to launch her, the weight of ship and launching gear being 10,800 tons. This did not succeed, and for three months she defied all attempts to get her off. At last, on the 31st of January, 1858, she was successfully launched, broadside on, into the Thames, and after another eighteen months' work upon her she was so far finished as to commence her career as a show ship on the Thames in the autumn of 1859.

Mr. Scott Russell adopted his wave line principle for the lines of the vessel, but to Mr. Brunel is due the idea of constructing her on the cellular system. She was built throughout of the best quality Lowmoor iron, 30,000 plates, weighing about 10,000 tons, and secured by 3,000,000 rivets, being used in her construction. From the keel to about 6 ft. above the 28 ft. water line she was double from stem to stern, or two perfect hulls one within the other, and about 34 in. apart; above this the outside shell was continued for a height of 24 ft. till it was connected to the cellular upper deck, the top of which was 30 ft. above the load water line. These two hulls were connected together by thirty-five longitudinal iron girders about 30 in. apart in the flat of the bottom, increased to about 60 in. apart at the bilges and up the sides, and this cellular hull was utilized so as to carry water ballast in any of the compartments when necessary. The interior of the ship and the cellular hull were each divided into eleven separate water-tight compartments by ten transverse iron bulkheads, two of which were 80 ft. and the rest 60 ft. apart; but there was none of the usual transverse framing in her construction. The holds were further subdivided by two water-tight iron longitudinal bulkheads 36 ft. apart, and extending for 350 ft. of the midship length of the vessel. The holds below the lower deck contained the machinery, boilers, stores and coal; and the upper part, three tiers of decks all fore and aft, was appropriated for passengers, the lowest of these decks being about 6 ft. above the water line. Between the machinery and boilers below, and the passengers above, a strong iron deck was fitted, thus cutting off all communication. The boilers occupied five of these central 60 ft. compartments and the engines two others, and the spaces between the longitudinal bulkheads and the cellular sides of the ship were appropriated for carrying the 12,000 tons of coal required for the voyage to India and back. The keel consisted of a flat plate 24 in. wide and 1 in. thick, instead of the usual bar keel. The shell plates were 8 ft. long, 33 in. wide and ⅞ in. thick, each weighing one-third of a ton, and the iron deck and bulkheads were of ½ in. plates. The upper deck, like the hull, was double, and formed a system of cells 2 ft. deep.

The cylinders of the oscillating paddle engines were four in number, 74 in. in diameter, 14 ft. stroke, and each one weighed twenty-eight tons when finished. The paddle wheels were 56 ft. in diameter, and steam for the engines was supplied from four double-ended tubular boilers, each 17 ft. 9 in. long, 17 ft. 6 in. wide, and 13 ft. 9 in. high, weighing without water 56 tons, and containing 39 tons of water, with forty furnaces. The chimneys were only 6 ft. in diameter, but being 100 feet high above the grate bars, there was an excellent draught. The cylinders of the screw engines were also four in number, 84 in. in diameter, 48 in. stroke, and each one weighed thirty-nine tons when finished. The propeller was four-bladed, 24 ft. in diameter. The screw propeller shafting was 150 ft. long, and weighed sixty tons, and steam was supplied to the engines by six tubular boilers of nearly the same dimensions, with seventy-two furnaces. The working pressure was 25 lb. per square inch, and each of the ten boilers was tested to a pressure of 60 lb. per square inch. Her calculated speed was 15 knots per hour, and it was expected she would make the voyage between England and India in thirty to thirty-three days, instead of eighty days, as taken by previous steamers, and between England and Australia in thirty-three to thirty-six days. She was designed to carry 4,000 passengers, viz., 800 first, 2,000 second, and 1,200 third class, a crew of 400, 5,000 tons of cargo, and 12,000 tons of coal, and if fitted up to carry troops alone, she had accommodation for 10,000. The total weight of ship and engines was over 12,000 tons, and when fully laden with passengers, cargo, and coal, she would weigh 27,000 tons, and be at a draught of 30 ft. She had five funnels and six masts. The actual weights were:

	Tons.
Iron in hull	7,296
Timber work and fittings	1,576
Masts, rigging, and sails	358
Anchors, chains, etc.	300
Paddle engines, complete	519
Boilers to paddle engines (full)	362
Screw engines, complete	607
Boilers to ditto (full)	632
Paddle wheels	185
Paddle boxes and sponson beams	350
Screw shaft and bearings	153
Screw propeller	37
Total	12,375

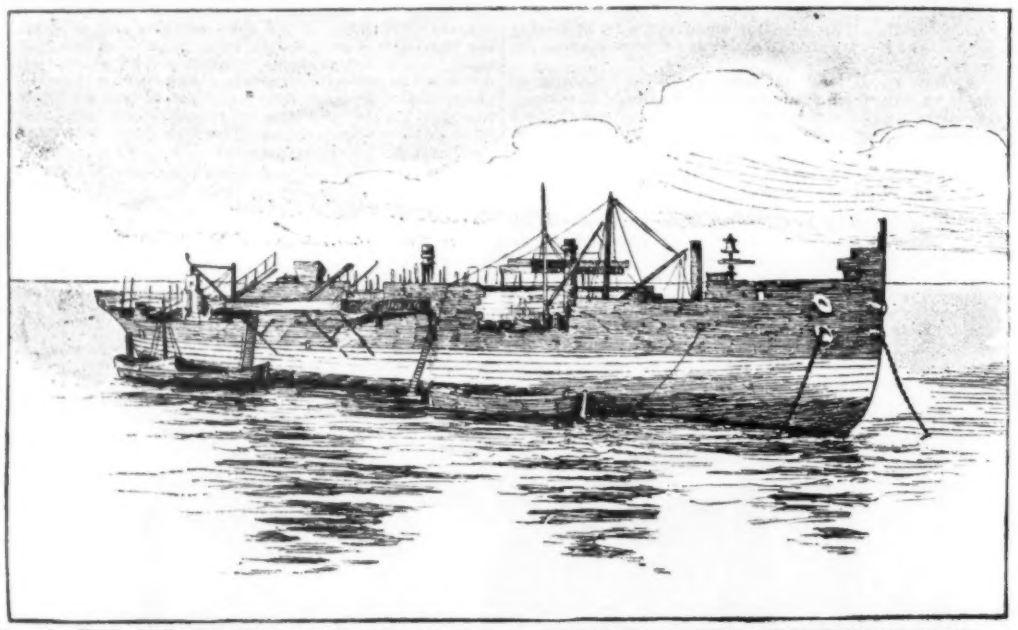


FIG. 1.—THE GAP FORWARD OF THE LADDER IS LEVEL WITH THE THIRTY-FOOT DECK.

FIG. 2.—STARBOARD SIDE BEFORE DROPPING THE STEM AND HAWSE PIPES.

On the 5th of September, 1859, she was towed to Purfleet, and the next day proceeded to the Nore under her own steam, where the tugs left her, and she started on a trial trip round the English coast. She had not got farther than Weymouth when the explosion of the feed water heater surrounding one of the chimneys occurred, killing and wounding several persons and destroying almost everything in the grand saloon, but scarcely injuring the hull at all. After the damage was repaired the season was too far advanced to attempt an ocean voyage, so about the middle of October she paid her first visit to Liverpool as a show ship and at the end of the month was taken to Southampton and laid up for the winter. In June, 1860, she made her first ocean voyage to America, chiefly as a show ship, for she only carried forty-two passengers out and sixty-eight home. Outward she ran 3,242 knots in 11 days 2 hours, giving an average sea-going speed of 12·2 knots, and burned 2,876 tons of coal; while homeward she ran 2,980 knots in 8 days

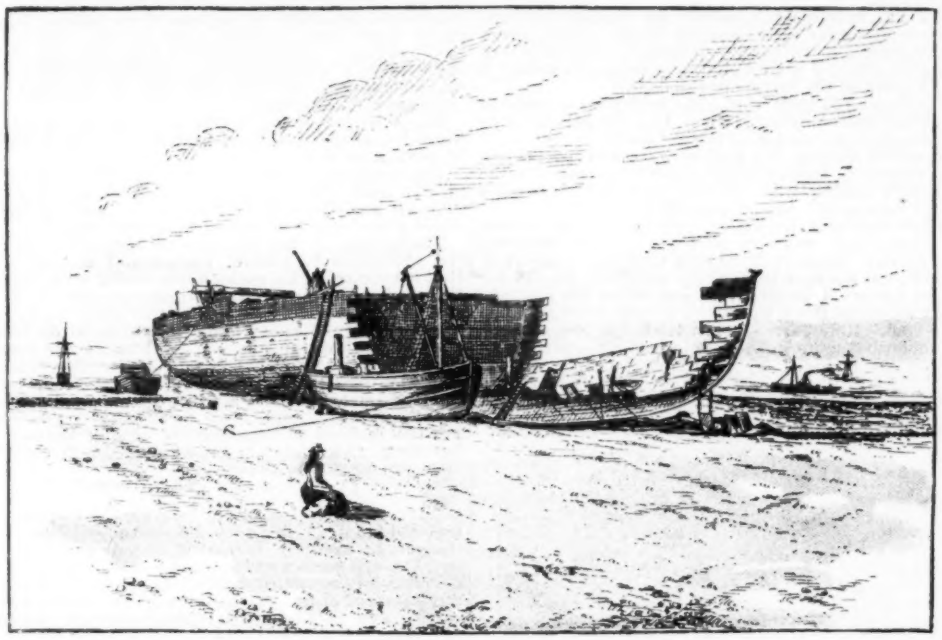


FIG. 3.—VIEW OF STARBOARD BOW.

20 hours, giving an average sea-going speed of 14 knots, and burned 2,744 tons of coal. This voyage was a failure financially, for though over 190,000 persons paid to visit her, the total receipts did not equal the total expenditure.

She was laid up at Milford Haven during the winter of 1860-61, and left there on May 1st for New York with 100 passengers on board, running a distance of 3,093 knots in 9 days 14 hours. She left New York on May 25th for Liverpool with 212 passengers and a large cargo on board, and arrived off the bar there on June 3d, making the passage in 9 days 13 hours. She was then fitted up, and took on board 3,300 troops for Quebec, and made about the shortest voyage on record to that port, as well as proving herself a steady and comfortable sea boat. Returning to Liverpool, she started on September 11th for New York, with 400 passengers and a general cargo, but about 300 miles off Cape Clear she encountered a very heavy gale, which disabled both paddle wheels and wrenched off the rudder head, and she lay like a log rolling heavily in the trough of the sea from Thursday evening till noon on Sunday. By this time temporary steering gear was rigged up, and she returned to Queenstown with her screw engines alone working, and making a speed of about 9 knots. She was again laid up at Milford Haven during the winter, and the necessary repairs having been effected, she made several runs between Liverpool and New York during the summer of 1862. In August of that year, on her voyage out, she struck on a rock off Montauk Point, and holed the outer shell plating, the fracture extending for a length of 80 ft., and a breadth of 4 ft. in some parts. This accident fully demonstrated the value and safety of the cellular principle of construction, as the inner shell remained intact, and she was brought safely into port without further damage to the hull or machinery, and no damage was sustained by the cargo. After temporary repairs were effected at New York, she returned to Liverpool, and was beached at New Ferry, where permanent repairs were carried out.

In the summer of 1863 she made several voyages between Liverpool and New York; but she did very little in 1864, until finally Messrs. Glass & Elliot chartered her, and this firm becoming the Telegraph Construction and Maintenance Company, fitted her out for cable laying. Mr. Cyrus Field then formed a company, and on the 15th of July, 1865, the Great Eastern left the Nore with the Atlantic cable on board. After many trials, the cable breaking several times, she had to put back with the work unfinished, although 1,800 miles of cable had been paid out. On the 30th of June, 1866, another attempt was made; and on the 27th of July success crowned the efforts of the plucky electricians. In 1868 she laid a telegraph cable from Brest to St. Pierre; in 1869 an Indian cable; and in 1871, 1873, and 1874 she successfully laid other Atlantic cables, and this closed the mercantile career of the largest vessel ever floated, without attempting the voyage for which she was designed and built, at a cost of £750,000.

Milford Haven was her final resting place, and there she lay idle for twelve years. In 1886 Messrs. Lewis, of Ranelagh Street, Liverpool, chartered her for a show ship from Mr. De Mattos, who had purchased her for about £25,000, mooring her in the Mersey and providing various attractions on board for visitors. A full description of her somewhat eventful voyage from Milford to Liverpool, additional historical particulars and engravings of the screw engines, will be found in the *Engineer* for May 7 and 14, 1886. From the Mersey she sailed at the end of 1886 for Dublin, returned in 1887, and afterward went to Greenock. In 1888 the owners, Messrs. Henry Bath & Sons, of London and Liverpool, decided to break her up at Liverpool, and sell her as old metal. The funeral procession left Greenock on the 23d August, the doomed leviathan being in charge of two tugs, and arrived in the Mersey on the 25th, with her own screw making 24 revolutions a minute. She steamed up the river to New Ferry, the hawsers were cast off, and at 2:30 P. M., half an hour after high water, she took the ground with her head pointing southwest. She was then drawing 16 ft. forward and 21 ft. aft, and her screw was kept working for some time to prevent drifting with the tide and to firmly ground her. She was endowed with a stubborn constitution from the first, resolutely refusing to take to her native element at her birth, and for three months defying the efforts made to launch her. So at her death she as resolutely refused to quit her native element in such an ignominious manner, breaking away from the tugs in a storm off the Calf of Man on her final voyage, and when picked up by them was found heading back to the Clyde.

Even after being beached, never to float again as every one thought, she made a last effort to escape her doom, and was found one night floating down the Mersey, and threatening to make a clearance of all the shipping in the river. After being again beached a number of compartments were left open to the sea, so that as the tide rose the water flowed into them, and thus effectually pinned her down. On the 20th to 25th of November, 1888, Messrs. Dixon & Moore, auctioneers, of Liverpool, who were instructed to sell the vessel, disposed of her with every piece of timber, rope, metal, and furniture in her. The iron selected for her construction was from the best Yorkshire makers of the day, and the metal turned out by the Lowmoor Company was of a quality which could not be surpassed. In addition to this the whole of the fittings were of gun metal, and under these circumstances it was to be expected that good prices would be realized. Some of the details of this unique sale may be interesting, and we, therefore, give the prices obtained for the principal items. A steam winch, by Taylor, of Birkenhead, brought £26; a shaping machine, by Whitworth, £51; one Trotman's anchor of 11 tons, 33 guineas. The rest of the anchors exceeded this figure, fetching £3 to £7 15s. per ton, the weights of the anchors ranging from 1½ to 11 tons. The copper steam and water pipes went to Messrs. A. Green & Co., of Liverpool, at £74 per ton; 80 tons of gun metal to Mr. C. Cohen, of London, at £80 per ton; 40 tons of scrap yellow brass to Messrs. Conner, McIntyre & Co., of Liverpool, at £44 per ton; as also 30 tons of sheet lead at £2 15s. per ton, and 300 tons of lead piping at £12 10s. per ton. The largest bid on the second day of sale was for 3,500 tons of ¾ in. iron plates, forming the main portion of the hull, by Mr. C. Cohen, at £3 12s. per ton, total £12,500. Mr. Kidson purchased 2,500 tons of other plates of various thicknesses at £3 6d. per ton. Messrs. G. Cohen & Sons, of London, 1,000 tons of angle iron at £2 10s.; 150 tons of rolled iron beams at £2 13s., 100 tons of scrap rivets at £2 6s., and 25 tons of boiler tubes at £1 19s. 6d. per ton. A few tons of shafting for throttle valve connections and some piston rods went at £5 10s. per ton, some eccentric rods at £4 5s. per ton and a dozen forged iron columns at £5 2s. 6d. per ton. The paddle engine iron forgings of eccentric straps, friction belts, crank shafts, and other parts, in all about 150 tons, at £2 10s. per ton. Two 100-ton hydraulic jacks went for £18, and a 40-ton jack for £7 5s.; a horizontal engine, feed pump, and all accessories, at £70; and the wrought iron propeller shafting, crank shafts, and other iron at £2 2s. to £5 5s. per ton. The paddle engine castings, including cylinders, bed plates, gratings, crank shafts, etc., to the extent of about 1,000 tons, went at £2 7s. per ton, the after capstan at £40 and the forward one at £55. The total amount realized by the sale was £58,000.

The paddle engine crank shafts, two paddle and an intermediate shaft—one of twenty-five tons and two of thirty-three tons—the whole of the boilers and steam pipe connections for both screw and paddle engines, the iron masts, and a large amount of scrap iron were secured by the Mersey Forge Company. Up to the present only two of the paddle shafts have been delivered. The third, weighing thirty-three tons, broke adrift from the deck of the barge on which it was being towed down the Mersey, and rolled overboard into 40 ft. of water. As the divers have not yet succeeded in finding it, it is now probably embedded in the sand at the bottom of the river. The screw engine crank and propeller shafts were secured partly by the Leeds Forge Company and partly by Mr. Walter Somers, Haywood Forge, near Birmingham.

Messrs. H. and C. Grayson, of Liverpool, secured the contract for breaking her up, but from various causes they could not begin this work until May, 1889. The rivets in the hull and boilers were cut out, so that each plate could be delivered to the purchaser with the least possible damage, but the whole of the castings of both screw and paddle engines were, by the aid of dynamite, broken up so that no single piece weighed more than one ton. They completed their task on the 30th of September, 1891, the operation occupying two years and four months, and thus the whole of this unfortunate ship from stem to stern, including hull, engines, and boilers, was reduced to scrap. We understand that most of the plates have been since shipped to Canada, and the angle irons and rolled beams to Italy. During the building of this vessel the great number of accidents to the workmen employed—many of which were fatal—was most deplorable, and with this as a warning, one of the greatest anxieties in breaking her up was to insure that every possible care should be taken for the preservation of life and limb.

The contractors' instructions were that no gear should be used for this work which was not perfectly sound and trustworthy, and so well were these instructions carried out by Mr. William Blighton, who had charge of this work, that Messrs. Grayson have the great satisfaction of knowing that the 10,000 tons of metal dealt with by them was broken up and removed without the loss of a single life or limb. Perhaps one of the most critical operations was the removal of the paddle shafts, each weighing over 30 tons. The Mersey Docks and Harbor Board have a 100-ton steam floating crane built for lifting heavy weights in and out of vessels, but when application was made for her services it was found they could not be relied upon. Consequently the good old fashioned plan of parbuckling was resorted to, by which means they were safely removed. To facilitate the work of breaking up, it

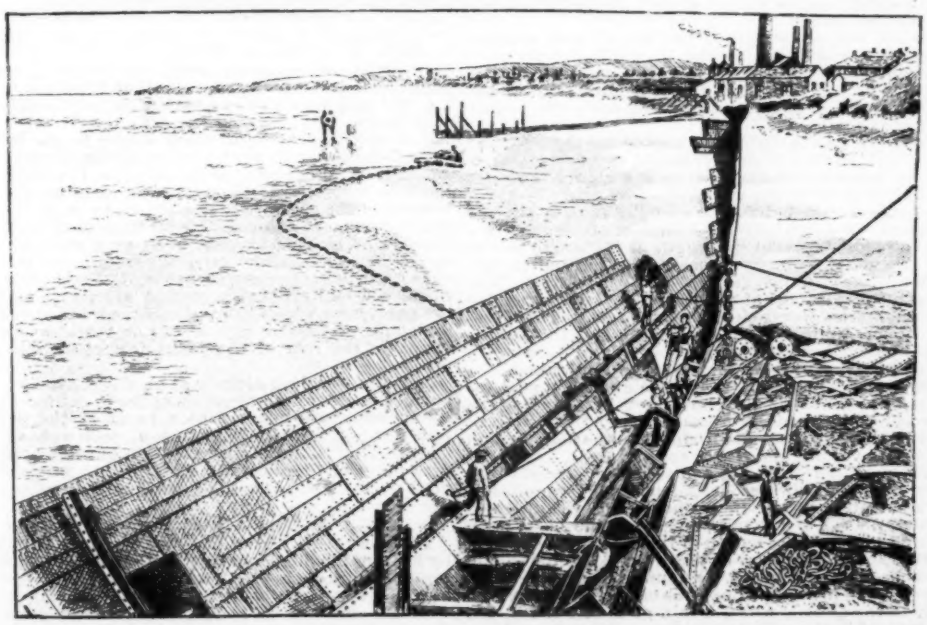
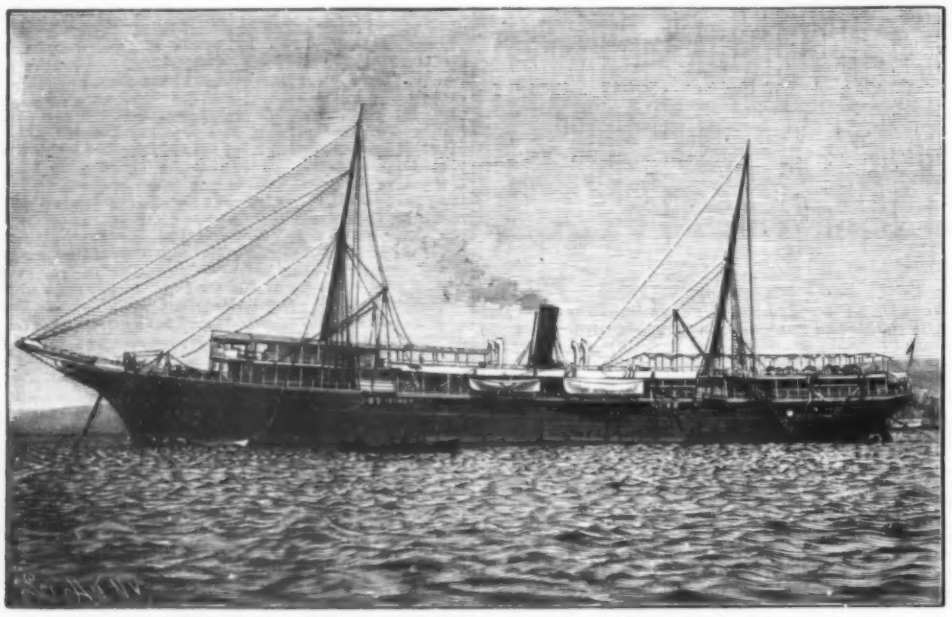


FIG. 4.—LOOKING TOWARD THE STEM AND SHOWING DOUBLE SKIN ON STARBOARD SIDE.

was desirable that the vessel's floating power should be retained, so that she could be moved farther up the shore from time to time as her draught lightened and the tides suited. During these rebeachings, so long as the cellular iron deck remained intact, no signs of straining were observed, but after a considerable portion of this deck had been cut away and she was again floated and grounded, the strain was more than the vessel could bear, and a fracture took place in the top-side plating, which as the tide left extended toward the bilge, leaving an opening 2 ft. wide, and thus proving what a great source of strength Brunel had given to the structure by the introduction of this cellular iron deck.

This great vessel, which from various causes was such a failure financially, was at the time she was built undoubtedly many years in advance of the times. Since then the size of steamers has steadily increased, especially of those engaged in the Atlantic and Australian passenger trades, until the Atlantic liner of the present day, 600 ft. long and 65 ft. broad, approaches much more nearly to the dimensions of the Great Eastern than to those of the Atlantic liner of 1850-60. Crippled from the first by the want of sufficient capital to finish fitting her up and properly to work the vessel, she was always in troubled waters; but her failure has been more the result of such financial difficulties than due to defective design or workmanship, or unfitness for the work for which she was intended or employed in. The opening of the Suez Canal in 1869 shortened the voyage to India considerably, and the great amount of tonnage passing through it made practicable the maintenance of coaling stations, and the supply of coal *en route* with dispatch and at a reasonable cost. The *raison d'etre* of such a vessel was thus annulled, and she could not take advantage of the new route in consequence of the depth of water in the canal being insufficient to allow her to pass through. The progress in marine engineering, from simple to compound engine engines, permitted the Atlantic liners with which she competed to be run with much smaller proportionate working expenses, and this, coupled with the weak financial position of the



THE CHILEAN TRANSPORT SHIP ITATA.

company owning the great ship, enabled the Atlantic liners to reduce their rates, so that, with the comparatively small number of passengers who favored her, she could not be run at a profit.

The views given are from photographs taken from time to time during the process of demolition. It was almost impossible to get a satisfactory proof, for when the camera was sufficiently near to give any idea of detail, it gave a poor idea of the vessel, and when sufficiently far off to take in any considerable portion of the vessel, all detail was lost. The above description, together with the views, will, however, give some idea of what she was like.

Fig. 1 is a general view of the vessel, showing how the three upper tiers of decks were first cut away all fore and aft down to the 30 ft. deck, *i. e.*, the lowest deck, which was 30 ft. above the inner hull. Fig. 2 is a view of the starboard side before dropping the stem and hawse pipes. Fig. 3 is a view of the starboard bow. Fig. 4 is a view looking toward the stem, and showing the double skin on the starboard side.—*The Engineer.*

THE ITATA.

WE give an engraving of this Chilean vessel that occasioned so much trouble to our naval department a few months ago. This is the boat that took on board a load of arms at San Diego for the Chilean insurgents, and contrary to the laws, sailed from the harbor, although technically under arrest. She was pursued by a war vessel of the United States to the harbor of Iquique, on the Chilean coast, there surrendered and taken back to San Diego.

Due legal proceedings were had, the vessel was recently discharged from custody, and has returned to Chile.

MODERN dwellings, and especially modern office buildings, are becoming a mass of mechanical, electrical, hydraulic and pneumatic contrivances. The putting up of a tall building requires almost as much careful engineering as in building a tower for the Brooklyn Bridge. Architects are continually calling upon civil engineers to solve the problems by which they are confronted in work of this kind.

GUN WRINKLES.

By G. D. HISCOX.

SHOT GUNS AND RIFLES.

MUCH of the satisfaction derived from the use of a shot gun or rifle is to know that its aim can be depended upon and that it is always ready for its best work.

In order to accomplish this condition the owner of a good gun should take pride in keeping it in first class order and be willing to sacrifice enough time for that work, cleanliness being of the first order.

The work of cleaning should always terminate the day's sport, or as soon as possible thereafter, by washing the bore of the barrel with hot water, wiping dry while the barrel is hot and pushing a swab slightly moistened with vaseline through the bore at least twice, and then wipe all the iron or steel parts of the gun with a cloth moistened with vaseline.

If the gun is to be put into a case, it should have a final wipe with a dry cloth, to prevent greasing the case lining.

If a rifle, examine the grooves by looking through the bore at a light, after cleaning, when, if there is lead in the grooves, it will show by a break in the continuity of the grooves; if a shot gun, by streaks or patches of a dull color on the surface of the bore.

The leading of both shot guns and rifles is lessened to a great degree by using wads that are paraffined or moistened with vaseline or clean tallow.

In breech loading shot guns using cartridges the end wad should be soaked with paraffin or tallow, while in breech-loading rifles the ball end of the cartridge should have a thin coat of paraffin or tallow.

When leading is noticed it should be removed at once by a hard wad, wet with kerosene oil and fastened to a wooden ramrod; if the lead does not come away at once, wet the bore thoroughly with the oil and let it lie for a short time or overnight, when the lead will easily separate from the barrel by the friction of the hard wad. Rifle barrels, when leaded in the grooves, are somewhat more difficult to clean. When the lead cannot be removed by the hard swab or scratch brush after soaking in kerosene, the barrel should be thoroughly cleaned out with hot water and strong soda, to remove all traces of the oil, and dried while hot. Plug one end and pour in two or three ounces of mercury and agitate the mercury over the leaded part by tipping the barrel. This operation will make an amalgam of the lead and mercury that can be pushed out by the scratch brush and oiled swab.

A wooden ramrod should always be used in sporting and fine guns.

A steel ramrod scratches the barrel and slightly abrades or bruises the muzzle.

Any defect at the muzzle will vary the direction of the shot or ball and make the aim uncertain; much of the perfection of range depending upon the perfect form of the muzzle.

Freeing a gun is slightly enlarging the bore toward the muzzle to give it greater range, or a flatter trajectory, by lessening the friction of the charge, but not enough to increase the windage.

A perfectly cylindrical or straight bore is not the best form for a gun barrel. A slight enlargement, for a quarter to one-third of the length at the muzzle end of the barrel, of a taper form at the beginning, but straight at the muzzle, is needed for best effect. The amount of enlargement can scarcely be comprehended by observation, for it should not exceed one five-hundredth of an inch enlargement of diameter, and is usually done by rubbing with a piece of flour emery paper attached to a cylindrical rod of hard wood.

Guns that are known to be straight bore may be given a modified or full choke bore by stopping the operation of *freeing* at the muzzle, so that the bore will swell from the middle toward the muzzle and draw into the original size at the muzzle.

The operation of freeing and choking a straight bore shot gun is a delicate one, yet may be accomplished by an amateur by the use of flour of emery cloth glued around the end of a round wooden rod, the emery occupying three inches in length of the rod and when ready for use should just enter at the breech. The rod should be split with a thin saw for four or five inches from the end, and pushed through the barrel from the breech to near the muzzle, where a thin piece of wood should be entered in the split, to give the emery paper a bearing on the surface of the bore. Then draw and push the rod back and forth and at the same time turning it around, so as to make the sweeps cross each other to keep the bore circularly true, using oil to keep the work of the emery free. By a careful manipulation of the strokes, the choke taper can be made by gradually shortening the strokes, so at last they should stop at about two inches from the muzzle. The same shortening of the stroke should take place at the middle of the bore, so as to produce a slight increase in size toward the muzzle.

The operation of freeing alone will be a much easier one and should be done in the same manner as described above, only that the emery cylinder should protrude from the muzzle at every stroke of the rubbing operation, while for choking it should always stop at the muzzle and shorter, as before described.

A straight bore is what its name means, a perfectly straight and cylindrical gauge throughout the bore.

A modified choke bore has the muzzle only slightly drawn in on an increasing taper, commencing about one inch from the muzzle, and should be less than one five-hundredth of an inch smaller at the muzzle than the bore of the barrel at the base of the choke. A full choke bore is only a little more drawn in than the modified form. The extreme allowance for full choking should not exceed one two hundred and fiftieth of an inch less than the bore, and commencing about two inches from the muzzle.

Choke boring of any degree is made to control the scattering of the shot by impacting it at the moment of leaving the gun.

The standard gun makers of the United States make all shot guns with choke bore. English and German guns are made both straight and choke bore, the choke bored guns being stamped to designate them.

The method of loading guns or cartridges enables the sportsman to control the amount of scattering that is required. To make a scattering shot place a thin wad on the powder and a thick one over the shot; and for a close shot, reverse the order of the wads.

For velocity of shot from a shot gun, with various charges and hints on shooting on the wing, see SCIENTIFIC AMERICAN SUPPLEMENT, No. 254. For description and illustration of a very curious property of double barrel shot guns, a lateral springing by firing, see SCIENTIFIC AMERICAN SUPPLEMENT, No. 441. For the method of manufacture of gun barrels, see SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 24, 25, 568.

A BALL FIRED VERTICALLY.

When a gun is fired absolutely in the vertical, the ball will fall a few inches to the south and west from the gun, in northern mid-latitudes; due west at the equator, and northwest in southern mid-latitudes. This deviation of the return ball is caused by the angular displacement of the vertical or radiant line from the earth's axis, at the point of discharge; the vertical line swinging on the earth's axis as a center by virtue of the earth's revolution to a measurable amount during the upward and downward flight of the ball.

For the same reason in northern latitudes a ball fired due south will deviate to the west and when fired due north will deviate to the east.

A ball fired vertically is retarded in both its upward and downward flight by friction of the air, so that its velocity at return will be considerably less than at the moment of leaving the gun, yet great enough to be destructive in its effect. The amount of retardation depends upon the relative densities of the ball and the air. If fired in a vacuum, or if there was no air, it would return with the same velocity as that of discharge.

From a record of firing in which muzzle velocity, time and range were observed, the loss of velocity at end of flight for iron balls was found to be 46 per cent. for muzzle velocities of 1,700 to 1,800 ft. per second; and 36 per cent. for velocities of from 1,200 to 1,300 ft.

For lead balls the loss should be somewhat less, for their greater density, say 40 per cent. for rifle muzzle velocities of 1,800 ft. per second.

The height that the ball attains before commencing its return is a neutral point between its flight and return, and from which the force of impact at return may be computed from the elements of gravity and the resistance of the air.

DIFFERENTIAL VELOCITIES.

When a ball is fired from a car under high speed, its velocity is accelerated, if in the direction of the car's motion, or retarded if fired to the rear, equal to the amount of velocity due to the speed of the car.

If a ball is thrown to the front with the same velocity that the car is moving, its actual velocity will be doubled. If thrown to the rear with the same velocity that the car is moving ahead, the ball will drop to the ground under the exact point that it left the hand, *i. e.*, the man moves away from the ball at the velocity of its flight.

If a ball is thrown at right angles to the line of motion of the car, it will not move in the direction of aim, but will move at an angle equal to the value of the two velocities, and if thrown at exactly the velocity of the car, it will deviate at an angle of 45° from direction of aim. This is an important point in shooting at moving objects, or from a swift-moving train. Thus a ball fired vertically from a car moving at 50 miles per hour, and occupying two seconds in returning, would strike the ground 140 feet ahead of the point from which it was discharged, less the retardation due to friction of the air; or would return to the car at the rear of the point from which it was fired.

Again, a ball fired directly at an object 500 feet off, at right angles to the direction of the car at the above speed, and with an average velocity of the ball of 1,500 feet per second, would pass 24 feet wide of the mark. This is one of the points requiring a sharp perception of the conditions of velocity in shooting birds on the wing, or animals on the run.

BLUING OF GUN BARRELS.

The most perfect method of bluing gun barrels is by heating in a muffle until the desired blue color is raised, then stopping the process by suddenly cooling in water, the barrel being first made clean and bright with fine emery cloth, leaving no marks of grease or dirt upon it when the bluing takes place. As this is somewhat difficult to accomplish in the hands of

amateurs, we recommend the fluid method as being more under control.

BLUING BY STAINING.

Clean and polish the barrel to a fine even grain with flour of emery paper or cloth, then brush or rub with a sponge or rag wet with a solution of one part protochloride of antimony (butter of antimony), one part nitric acid, two parts hydrochloric acid. Add the hydrochloric acid last drop by drop, to prevent heating. As soon as the barrel is thoroughly wet, rub the surface of the barrel with a piece of green young oak wood until the desired blue color is produced.

BLACK BY STAINING.

Clean the barrel as above described and sponge with a solution of four parts of protochloride (butter) of antimony, two parts sulphuric acid, one part empyreumatic pyroligneous acid or gallic acid. Apply several coats, or until the surface is black enough.

BROWNING BY STAINING.

Clean the barrel as above and sponge with a solution composed of one ounce alcohol, one ounce tincture of iron, one ounce corrosive sublimate, one ounce sweet spirits niter, three-fourth ounce sulphate of iron, one-half ounce nitric acid, in one quart of hot water; keep in a glass bottle. Apply with a sponge or rag; expose to the air for a day; then rub with a steel scratch brush or card until the loose rust is entirely removed. Then apply the mixture again and expose as before, and a third time if the second is not satisfactory, using the scratch brush or card after each exposure, when the barrel should have a dark and even brown color.

In operating with these processes, always plug the barrel tightly at both ends.

AFTER TREATMENT.

After staining with any of the acid processes above is complete, the barrel should be thoroughly washed with boiling hot water, to clear it of all traces of acid, quickly dried, and while hot rubbed with paraffin, boiled linseed oil, or, if a varnish is preferred, use shellac varnish or copal varnish on a piece of soft leather; wiping the varnish on quickly and thin, so as to make a smooth, even finish.

For keeping barrels from rusting when in use and where conveniences for heating are not at hand, the frequent wiping of the barrel and all iron or steel parts with a rag moistened with vaseline, which can always be kept ready for use in a small tin box, will be found most effective.

MOTTLING OF GUN TRIMMINGS.

The mottling of locks, hammers and trimmings of guns is done by the casehardening process, and has no further peculiarities than the protection of the surfaces from the oxidizing effect of air while in the process of heating, and the rapidity of transfer to the water when at a proper heat for hardening. The process consists in packing the pieces carefully in animal charcoal, such as charred leather, scraps of hoofs or horns, charred and pulverized so as to allow it to pack closely in contact with the surface of all the articles in an iron box (cast iron preferred), with a cover to fit closely inside, so that, if the box is not full, the cover will set in contact with the material.

Pack so that no piece touches another on their faces or sides that are to show mottling; press the cover down and put a little fine sand on top around the edges, to prevent air entering between the cover and box. Heat the box in a forge or furnace fire to a bright red heat; keep it at this heat for fifteen to twenty minutes, according to size of box, then take off the cover and seize the box firmly with a pair of tongs; hold it over a tub of water, tip the box and spill gently the contents (iron and charcoal) into the water. The time of dropping the pieces into the water governs the depth of color, and this must be had by practice. Turning the box over slowly and at the same time shaking it clears the pieces from the charcoal and gives each piece a short exposure to air while hot; which gives it its color or cloudiness.

The distance that the box may be held above the water may vary from six inches to two feet. Also varying the depth of color and the various positions in which each piece touches the water gives variety to the figures and shades.

The work should be immediately taken from the water and dipped in boiling hot lime water, dried and oiled.

THE ETCHING OF NAMES, CRESTS OR MARKS.

The process of etching a name or crest is not difficult, but should be confined to the lock or a plate let into the stock; the lock is a favorite place.

The piece should be made clear of oil, grease or varnish by cleaning with turpentine or caustic soda. A thin coat of asphalt varnish may be spread on the surface with a camel's hair pencil, or a mixture of asphalt and beeswax dapped on the warmed surface with a cotton wad in a piece of silk. Then with a steel point trace the name or design by scratching the lines down to the surface of the metal, so as to leave none of the varnish or wax on the surface that is intended to be etched. Then make a roll of beeswax soft by warming, flatten it and lay a border all around the design to keep the acid from spreading where it is not wanted. For the etching acid prepare in a small bottle one part nitric acid, four parts water, two parts acetic acid, and pour enough on the etching to cover the surface. It should bite sufficiently deep in from ten to fifteen minutes. If the acid does not seem to take hold evenly, which will be known by the rise of little bubbles from all the lines, make a voltaic circuit by bending a small strip of sheet zinc and touching the metal outside of the wax wall with one end and the surface of the acid with the other end. An active evolution of gas bubbles from the etched lines will at once show the action of the acid. When the acid bite is thought to be sufficient, pour off the acid and wash, then remove the wax border and clean off the etching wax by heating and wiping or with turpentine.

Another style, where a name is bright with an etched background, is done by writing the name with a fine camel's hair pencil with thin asphalt varnish, and inclosing a space around it with the brush and varnish; then make a wax border and etch the background as above described.

[FROM THE CHATTANOOGA TRADESMAN.]

COTTON SEED OIL AND THE PRODUCTS OF THE COTTON SEED.

By D. A. TOMPKINS.

FROM time immemorial the praises of the olive tree have been sung both in sacred and profane literature.

For centuries before and after the Christian era it was held, and is still held, in the highest esteem. This high estimation in which the olive tree is and has ever been held comes undoubtedly from the fact that in its fruit and oil mankind has heretofore obtained more from it that is useful than from any other plant or tree.

It was an olive branch that the dove brought back to Noah in the ark to give courage and hope to the survivors of the flood. The olive branch is well nigh a universal emblem of peace among all peoples.

In ancient times, and in many countries still, olive oil is the principal and in many cases the only cooking grease. Our Anglo-Saxon habit of using animal fats in its stead is the exception, and not the rule. In the Arabian Nights the forty thieves were concealed in jars that were supposed to contain oil.

Throughout the same ages the cotton plant has always existed, but remarkable as it may seem, its value seems never to have been understood until within the past twenty-five years.

The three prime necessities of the human race are: Food, clothing and shelter.

Toward supplying these, the olive tree furnishes its fruit and oil for feed, and in a very limited extent its wood for construction.

The cotton plant now supplies lint from which clothing, for the body, the bed and household (carpets) are made. It supplies oil for cooking purposes, and for many industrial uses—for use in lamps in mines, for lubrication in cutting threads on pipes and bolts, for making soap, glycerine, candles, butter, lard and innumerable other uses.

The cotton seed meal is used for supplying ammonia and other constituents in commercial fertilizers, for food for cattle and dairies, for fattening beef, sheep, and for various other purposes. Lately, however, it is being largely used as a food for cattle and sheep. This is especially the case at dairy farms, where cattle are being fatted for beef, and at saw mills, where oxen are used to haul logs.

In truth we are suddenly brought to a realization of the fact that the cotton plant gives us more than the olive tree ever gave to mankind, and for protecting machinery and methods for the protection of useful products from cotton seed, values which have for centuries been unknown have suddenly been brought to light. The men who have been most instrumental in the production of valuable products from cotton seed have been doing a work not only for themselves, but for the country at large and for civilization.

The First Cotton Seed Oil Mills.

A man named Martin operated a cotton seed oil mill in New Orleans as far back as 1847. But few other mills were built prior to the civil war.

Immediately after the civil war of 1860 to 1865 several mills were built, some of which succeeded and some failed. By 1870 the business of crushing cotton seed had developed into a distinct and entirely legitimate business, but the processes employed and everything pertaining to the industry were held in great secrecy.

The oil was found to be about the same as olive oil, and the meal was largely exported and used in England and on the Continent for stock feed. What was purchased in America was principally used as a fertilizer.

The oil was used principally as a substitute for an adulterant of olive oil, and readily sold for 50 to 60 cents per gallon, crude.

Those mills that were managed with even a rough approximation to ordinary care and business judgment made very large profits.

As the business still developed, and the price of oil became less, the pork packers discovered that by adulterating it with beef stearine it could be sold as lard.

Since its introduction to this use large and increasing quantities have been consumed by the pork packers. Since about 1880, the consumption of cotton seed oil has been largely increased by its use for packing sardines on the coast of Maine, for making butter in America, Holland and elsewhere, and for innumerable other purposes.

The Machinery Used.

The principal machinery used in the earlier cotton seed oil mills was brought from England. It was no doubt such heaters and presses as were used to crush oil from linseed, some Egyptian cotton seed and other oil seeds that were produced or shipped to England.

The Egyptian cotton seed are black and lintless, very similar to seed from sea island cotton in this country.

The process of working them was very simple. They were first crushed under old fashioned milling stones, then put in steam jacketed kettles with mechanical stirrers and cooked. The product was dumped from the kettle or heater into a wooden bin, and from the bin it was put into small cloth sacks, these being in turn inclosed in a hair mat. The whole was put into a hydraulic press containing about five boxes, and put under about two to three thousand pounds pressure to the square inch, on rams ten to twelve inches in diameter.

The upland American seed are not entirely free from lint. On account of the quantity of oil this lint is capable of absorbing, and also on account of the injury the lint is to the cake as a feed stuff, it was important to separate the hull from the meats.

This was accomplished by the use of a huller, a machine to cut seed to pieces, and then screening out the meats from the hulls in boiling chests having the reel clothed with wire cloth.

The earlier mills built were either built by foreign mechanics or native Southern mechanics of ante-bellum type, both of which are dogmatic, opinionated and incompetent. It commonly required about

Two Years to Build a Mill

and get it in successful operation.

Up to about 1880, the owners and the mechanics, who knew the process, maintained the greatest secrecy possible, as to the cost of a plant, the profits and the manner of its operation.

The new condition of things brought about by the results of the war in the South developed very quickly a much better class of mechanics and engineers than foreign and "rule of thumb" native mechanics that had formerly held sway. Some of the new men were native and some came from the North. About 1880, some mills were brought to a degree of efficiency and economy of operation far exceeding what had before been accomplished. The mills of George O. Baker, of Selma, Ala., and O. O. Nelson, Montgomery, Ala., were notably more improved than the average about this time.

In 1883, Mr. Fred Oliver went from Cohoes, New York, to Charlotte, N. C., and established an oil mill. It was very soon made apparent that the so-called oil mill experts had some mechanical ideas that were very crude and had little or no capacity to make designs of manufacturing plants. He, therefore, abandoned all effort to have a mill built by the experts and undertook the work himself, aided only by some conferences on mechanical matters with the writer and Mr. Liddell, from both of whom he purchased some of his machinery. This mill was an unqualified success and in its construction many mechanical faults of older mills were eliminated.

Only a little before this, the increased production of oil and the improvements made in new mills caused some of the older mills alarm. In Arkansas and Texas the field for seed was being more and more actively worked. The outcome of this competition was

The Formation of a Trust,

into which four mills of Arkansas and Texas entered. The original idea was to protect the four mills from the competition with each other. To the surprise of the formers of this trust, it was found that other and more successful oil mill companies became alarmed and interpreted an action that was an evidence of weakness as an evidence of strength. Every mill owner wanted to get into the new trust. The terms of the deed of trust were kept strictly secret, yet the less a mill man knew about it, the more he wanted to get in. Some few objected, but threats and claims of untold power on the part of the trust ultimately caused the bulk of all the mills to go in. Those few mills that stayed out reaped a rich harvest. The formation of the trust was begun about 1882, and the last mills were taken in about 1887.

Many of the men who best understood the oil mill business had been constrained by their own judgment to go into the trust because their mills were becoming old and unfit to compete with the new mills then being designed and built by competent engineers.

The mill built by the Oliver Bros., at Columbia, S. C., in 1884, was probably the first oil mill ever built from carefully prepared plans having in view complete organization of all the machinery.

Almost all the mills that comprised the trust were old and much worn. The insurance rates in them ranged from six to nine per cent, with very few exceptions. The operation of many of them was discontinued entirely. Nevertheless, it seemed for a while as if the trust was in possession of the cotton seed oil business, for it was plainly intimated that any new mill would be crushed.

The only hope of the trust for success was to control the business and keep the price of seed low and of product high. Most of their mills could not be operated with competitive economy. During the one year in which the trust had practical control about four hundred thousand tons of seed were purchased at an average price of three dollars per ton lower than they would have brought in a competitive market, being the equivalent of about one and a quarter million dollars

Loss to the Producer on Seed Alone.

Just at this juncture the idea was conceived by Mr. Fred Oliver of arranging a company to build a series of new mills so located as to cover the entire seed territory. He associated with him Mr. Henry C. Butcher, of Philadelphia, and others, to organize the Southern Cotton Oil Company, which was accomplished in the spring of 1887.

The trust was exceedingly confident of their ability to cope with any new company. Their experience in mill building had been that it took about two years to build a mill and get it in successful operation. They ridiculed the idea that the proprietors of the Southern Cotton Oil Company could build and put in operation eight large mills in less than one year.

Plans of all the mills were made in complete detail. Eight skilled managers were engaged, one to take entire charge at each of the points selected, and the eight mills were successfully built and put in operation in about six months' time from the time work was begun, and the company crushed about two hundred thousand tons of seed the first season. The trust suffered so much in the competition that some of the principal officers were compelled to resign, and the trust properties went into new hands and its financial affairs were put under new management. Propositions were at once made for some sort of coalition with the new company, and a "working arrangement" was ultimately entered into by a vote of the boards of the two companies. This arrangement was entirely unsatisfactory to the Olivers and their friends of the Southern company, and they sold their stock and severed their connection with the company in the spring of 1889. Three new companies were immediately organized, one by Mr. Fred Oliver, at Charlotte, N. C., one by Mr. John Oliver, at Atlanta, Ga., and one by Mr. J. S. Price, at Houston, Texas. By the influence of this movement about twelve other smaller companies were organized in the same year, and the oil business was again open to any one who wanted to go into it on a competitive basis. In the last two years about fifty new mills have been constructed, all of which are now in more or less successful operation. By reference

to the tables of all the mills herewith published it will be noted that the business is very general, both in the number of corporations engaged in it and in the territory covered.

In most of the new mills now being built, much more than an oil business is comprised. The designs are based upon the idea that seed cotton is a raw material, out of which should come in one plant the following marketable products:

1. Lint cotton in bales.
2. Cotton seed hulls in packages for stock food.
3. Cotton seed meal in sacks for stock food.
4. Cotton seed meal in sacks for fertilizer.
5. Cotton seed oil in barrels.

By incorporating into our works a ginnery, an oil mill, a fertilizer works and the facilities for feeding cattle on hulls and meal, we are enabled to take seed cotton as a raw material, perform on it a cycle of operations by which we may get those products that are marketable, and return to the farmer those that are useful only to the soil. A number of mills incorporating these features have lately been built. Two distinct types have been developed which we may designate as "central" and "county" mills.

The central mill is one having the capacity to crush about 100 tons of cotton seed in 24 hours. Such a plant built at Charlotte, N. C., comprises a ginnery, a cotton seed oil mill, sulphuric acid chambers, an acid phosphate works, and a cotton oil refinery. Oil from smaller mills is bought or refined in this plant, acid phosphate is made and sold for mixing with cotton seed meal as a fertilizer.

The county mill is one having the capacity to crush about 30 tons of seed in 24 hours. It has a ginnery also and appliances for manipulating commercial fertilizers, buying the acid phosphate and some other ingredients for use with cotton seed meal.

In either type of mill stock feeding may be profitably done.

THE MANUFACTURE—THE PROCESSES EMPLOYED IN SECURING THE SEED PRODUCTS—VALUE OF THE PRODUCTS.

Sea island cotton seed are black and entirely free from lint.

The great bulk of seed worked are upland seed. These, as they come to the mill from the gin, are physically composed about as follows:

Short lint	75 lb.
Hull	925 lb.
Oil	390 lb. = 52 gals.
Meal	610 lb.

In different seasons and in different soils, these figures may vary. By bad ginning there may be 125 pounds of lint left on the seed, and by very good ginning the seed may be cleared of lint to within 50 pounds.

The best possible oil mill is one in which the above constituents are most nearly completely separated in marketable shape at the least expense per ton.

In the mills that were operated in England, Egyptian seed being the raw material, the following is about the process employed.

The clean, black seed (very much the same as our sea island seed) are put into a vessel and crushed under two muller stones. The crushed seed, hulls and meats together are then put into steam jacketed heaters, cooked, then in proper packages are put into the boxes of a press between hair mats and pressed. The resultant cake contains all the hull, is very dark, almost black, and is used as a stock feed.

In the first American mills for upland seed it became necessary at once to separate the meats from the hulls on account of the oil the short lint would absorb, and because also the lint was injurious when fed to stock in the meal. Therefore, it became necessary to add to the above process a huller and a bolting chest, commonly called in oil mills a reel, to separate the hulls from the meats.

The process remained practically the same until about 1880. From that time forward great improvement has been made, notably in machinery we may mention, improved hullers, improved linters, steel plate boxes in presses requiring no hair mats, chilled rolls in place of muller stones, etc.

The Process.

The process as now conducted in first class mills is about as follows:

1. The seed are cleaned of sand.
2. Then the other foreign substances, such as rolls, pieces of wood, etc.
3. They are then carried to the linters and reginned for a part of the short lint.
4. They are then carried to the huller, which cuts them to pieces.
5. Then in a reel the meats are separated from the hulls.
6. The hulls are then taken out, heretofore to the fire room, for fuel, but latterly to be sold as cattle feed.
7. The meats are taken to the rolls, which crush them, breaking the oil cells.
8. From the rolls the meats go into heaters, in which they are cooked.
9. From the heaters meats are taken into the former, where cakes are formed and inclosed in cloth.
10. The cakes are placed in the press and the oil extracted by pressure.
11. The cake remaining in the press is taken out, allowed to cool, and it may then be cracked and ground into meal.

In the old mills about the following products were obtained, which sold at about the prices indicated:

1,000 lb. hulls, used as fuel	
775 lb. meal at 90 cents	$6 75
225 lb. oil = 30 gals., at 60 cents	18 00
2,000 lb. seed giving products worth	$24.75

In such a mill the cost of working a ton of seed was about $5, and the cost of a ton of seed delivered in the mill was about $10, making a total cost to the mill of about $15 for products readily salable at about $25. Therefore, a mill capable of working 5,000 tons of seed per season should have made and did make about $50,000 per year.

At the present day meal remains about the same price. Oil, however, has declined fully one half. By improved mills and machinery the cost per ton of working seed has been much reduced, and the quantity of oil per ton has been increased.*

Many mills exist that can never be made first class except by entire reconstruction. Of the mills still being built, there is much variation in the quality of the design and workmanship on the machinery.

In the following estimates we will undertake to show the results in different kinds of mills under different conditions. The estimates in all cases are for product from one ton of seed.

Estimate of results in an old or badly constructed mill in a good year:

Oil, 39 gals. at 30 cents per gal		$11.70
Meal, 675 pounds at $1 per cwt.		6.75
Hull, 950 pounds at $3 per ton		1.42
Lint, 15 pounds at 5 cents		75
		$20.62
Cost of seed delivered in mill	$14.00	
Cost of working, bags, barrels, etc.	3.50	
Cost of fuel per ton	1.00	
		18.50
Profit		$2.12

Say $2 per ton net, then, in a mill working 5,000 tons there would be a profit of $10,000.

Estimate for same mill in a bad year:

Oil, 35 gals. at 20 cents		$7 00
Meal, 675 pounds at 90 cents per cwt.		6 08
Hull, 950 pounds at $3 per ton		1 42
Lint, 15 pounds at 5 cents		75
		$15.25
Cost of seed delivered in mill	$12.00	
Cost of working, bags, barrels, etc.	3.50	
Cost of fuel per ton	1.00	
		16 50
Loss		$1.25

Or say a net loss of $1 per ton, which on 5,000 tons seed would be $5,000.

Estimates for well designed mill, having the best machinery, in a good year:

Oil, 40 gals., at 30c. per gal.		$12 00
Meal, 675 lb., at $1 per cwt.		6 75
Hull, 950 lb., at $3 per ton		1 42
Lint, 30 lb., at 4c. per lb.		1 20
Total		$21 37
Cost of seed in mill	$14 00	
Cost of working, bags, etc	3 00	
Cost of fuel	75	17 75
Profit		$3 62

Or say, in round numbers, $3.50, which on 5,000 tons seed = $17,500.

For the same mill in a bad year—

Oil, 40 gals., at 20c.		$8 00
Meal, 675 lb., at 90c.		6 08
Hull, 950 lb., at $3 per ton		1 42
Lint, 30 lb., at 4c.		1 20
		$16 70
Cost of seed delivered in mill	$12 00	
Cost of working and packages	3 00	
Cost of fuel	75	15 75
Profit		$0 95

In round numbers, about $1 per ton profit, which, on 5,000 tons of seed, equals $5,000. This would be 10 per cent. on a capital of $50,000, or a good, fair interest on the money in the worst year.

These figures all apply rather in the Eastern States than west of the Mississippi River. They apply also to the oil mill business alone.

As a matter of fact the best modern plants in the East comprise in one factory a ginnery, oil mill and fertilizer works, each of which departments helps the others out.

Throughout the entire South

The Use of Hulls for Fuel

is being rapidly abandoned, and they are being used as stock food, many mills having added to the business that of fatting cattle for beef. The hull and meal together has been thoroughly demonstrated to be excellent food for fatting cattle for beef or for fatting dairy cattle.

Oil mill plants have been, in fact, so perfected in design that in one plant it is contemplated to put the seed cotton as a raw material through a complete cycle of operations as follows:

1. Separating the lint from the seed.
2. Separating the short lint.
3. Separating the hull and meat.
4. Separating the oil and meal.
5. Mixing meal and other ingredients for fertilizer.
6. Feeding hull and meal to cattle, using the manure as a fertilizer.

Thus taking seed cotton as a product from the soil, we take out the products that are valuable for clothing or animal food and return what is useless for these purposes back to the soil to make the new crop.

Taking a basis of eight million bales as the cotton crop of the South, we would get four million tons of seed. Out of these seed and by the most improved processes now employed, we might obtain the following products worth the prices set opposite to them at the present market values:

Forty gallons of oil per ton out of four million tons of seed—160,000,000 gallons at 30c.	$48,000,000
Two million tons hulls, at $3 per ton, as stock food	6,000,000
One and one-fourth million tons meal, at $15 per ton	18,750,000
One hundred and twenty million pounds short lint at 5c.	6,000,000
Total	$78,750,000

This sum represents the values of the naked products of cotton seed in a cotton seed oil mill in the present improved processes of manufacture. The total seed crop of 1890–91 as used by ante-bellum planters would not have been worth more than five million dollars as against eighty million (speaking in round numbers), if utilized according to the present known methods of manufacture.

But the values indicated represent even much less than the consequential results.

Two million tons of hulls, and proper proportion of meal, will feed untold numbers of dairy cattle.

From these come beef, tallow, glue, etc. The oil, besides being useful in itself as a cooking oil, as a lubricating oil, when properly prepared, as a paint oil, as an illuminating oil, etc., gives also glycerine, soap, candles, lard, butter, and infinite other products and industries. Notable as an example to the uses which it goes, the cylinders for Edison phonographs are made from the "soap stock" residue in refining cotton oil.

REFINING COTTON OIL.

The question is frequently asked in the South: "What would the necessary machinery and appliances cost for a factory to can fruits and vegetables?"

Many men who ask this question might, by close observation at home, find that the cooking stove and utensils constituted a complete equipment for not only canning fruits and vegetables, but for making jellies, preserves, etc.

In the same kitchen, with the same utensils, and with materials exactly similar, one housewife will make most excellent preserves, while another with ever so much pains cannot do half so well.

The difference in the result is a difference in skill.

In refining cotton oil it is very much the same. Knowledge of the refining process is not sufficient to make a refiner, no more than a knowledge of the principles of music makes a performer. After knowledge, skill must be acquired by patient practice and close observation.

Refineries are usually built to refine seventy-five to two hundred barrels per day. There are few instances of smaller refineries being successful, mainly because a skilled refiner cannot usually be employed for less than fifteen hundred to twenty-five hundred dollars per year, and the capacity of the refinery must be sufficient to justify this fixed charge.

An unskilled man might, by spoiling one or two "batches" of oil, cause more loss to a company in a day than could be repaired by profit in a year.

With the next generation, after boys now about oil mills and refineries have grown up, it will be different. Skill will be more abundant, and the ability to refine and manage a crude mill will be more frequently combined in one man than it is now. When this is the case it will pay to refine at the smaller mills.

As in canning fruits, so in refining oil, the complete process may be performed in a kitchen, using the cooking stove and ordinary kitchen utensils. The cost of a refinery for a mill depends upon the capacity and the extent of the equipment to make the operations cheap.

Almost any good refiner will tell all he knows about refining cotton oil without fear of competition. As a negro cook once said about making good waffles in answer to an inquiry as to how it was done: "It's not in the telling, but in the doing. I might tell you twice over and then you can't do it." This matter of the skill necessary should be fully understood by any company before spending the money necessary for the plant.

CLEANING MACHINERY — SEPARATING THE LINT FROM THE SEED—THE STORAGE OF COTTON SEED.

"There's a bag of gold at the end of the rainbow."

In the oil business there is a fortune in store for the man who invents a means of cleaning upland seed of lint, so that they have the appearance of sea island or Egyptian seed. This is the legend of the oil man. The country is full of inventors trying to make seed cleaning machines. Most of the workers at the problem have never stopped to ask the question where the fortune would come from or why it should even be expected that there would be a profit in a perfected seed cleaning machine. Many machines have been invented and made, quite a number of very good ones, but nobody has yet made the fortune.

On the coast of South Carolina and Georgia the seed from sea island cotton are clean from the first ginning. At the Savannah mill of the Southern Cotton Oil Company, Mr. L. W. Haskell has purchased and worked quite a quantity of these seed, and his ultimate conclusion is, we believe, that they are less profitable to a mill than upland seed.

Whenever any evidence is exhibited at all in support of the assertion or idea that a seed cleaning machine would be valuable, the argument is about as follows: The price of seed in America is $10 per ton; in England it is quoted about $24 per ton. Therefore, if a seed cleaning machine could be invented, there would be a fortune in it.

As a matter of fact, when seed are quoted at $10 in this country and $24 in England, the meaning of a ton in this country is 2,000 lb. and in England it is 2,240 lb. If this be considered and there be added to the cost of seed in this country the cost of cleaning, freight to port, ocean freight, handling and commissions on the other side, and freight to mill on the other side, it will be found cheaper to work the seed in America by the usual American process. The seed from sea island cotton are already clean, and are also already near ports in most cases, and yet no business has ever been developed in shipping them abroad. The reason is that if they can be purchased at a rea-

* The powerful oil mill machinery, made by the D. A. Tompkins Company, Charlotte, N. C., is as follows: The sand and boll reel is made to clean the seed; taking out everything larger than a seed, and also everything smaller than a seed. For small mills a sand and boll reel is combined in one machine. For large mills the sand and boll reel are separate machines. The separating machine, or reel, is for separating the meats from the hulls. Besides the reel proper, the machine has a shaker to perfect the work of separation. The huller feeder is a machine designed to accomplish two results, viz.: To give to the huller a regular feed and to prevent foreign matter larger than cotton seed from going into the huller at all. The cake cracker is to break cake, preparatory to grinding it into meal. The rolls are chilled, have wrought iron necks, built in various dimensions, and to drive by belts or gears, as may be preferred. The heaters are steam jacketed full height of sides, as well as bottom. The charging hoppers are wrought iron. The substructure, gearing, and all parts of the heaters are substantially constructed. Besides the steam jacket to do the cooking, the sides and bottom are jacketed outside with felt held on by Russia sheet. The former is a direct-acting steam former, and has a separate steam cylinder to operate the carriage which distributes the meats in the former bed. The presses have steel plates, well drained. They are simply and durably constructed.

sonable price, it pays better to work them in this country than to attempt to ship them.

Linting.

Much has been said also about the value of the lint that is not true. After seed are well linted by an ordinary linter, what is left on is not of much value as fiber or paper stock.

A good linter gets from thirty to forty pounds of lint from a ton of seed when about five tons per day is put through it. It is a considerable question whether it is best to lint once, twice, or three times.

Assuming a linting capacity to get say thirty pounds of lint per ton, the linters may be so arranged as to run the entire seed through say one-half the linters, getting fifteen pounds per ton, and then running them through the other half, getting fifteen pounds more. The first linters would sell at say five cents per pound, making seventy-five cents per ton. The second linters would then bring three cents per pound, making forty-five cents per ton, making a total of one dollar and twenty cents per ton.

On the other hand, running the seed through all the linters straight would give, say thirty pounds of one quality, which would sell at about four cents per pound, making one dollar and twenty cents per ton also. The question of profit on the relinting plan or otherwise would depend more on the market to be reached than upon anything in the mill.

Storing Cotton Seed.

Punch's celebrated "advice to a man about to get married: 'Don't,'" might equally apply to the man who is operating a cotton mill, and is contemplating increasing the storage capacity for cotton seed in order to make a larger season's work.

Cotton seed are very perishable, and the danger of heating might be estimated at ten per cent. of their value.

Assume that we have the following conditions, viz.:

A mill having a capacity of 30 tons per 24 hours.

Storage of 1,000 tons seed.

Then, from September 15 to February 15, the mill would work about 3,000 tons; allowing for breakdowns and holidays.

Now, to work 5,000 tons instead of 3,000, how shall this be done? By increasing storage capacity to the extent of 2,000 tons, making 3,000 instead of 1,000, and using the same machinery, or, by leaving seed storage unchanged and adding additional machinery to work the 2,000 additional seed in the same time.

By adding storage, we would have the following items of additional expense:

1. Liability of seed to rot or damage.
2. Interest on money invested in 2,000 tons seed stored in addition to the quantity to keep the mill in regular operation.
3. Less oil per ton on stored seed than on seed worked fresh.
4. Less price on oil out of stored seed if in any way heated.
5. Additional labor for working same tonnage for a longer time.
6. Interest on increased warehouse cost.

Now, if instead of increasing storage capacity, we have the following additional expenses:

1. Interest on value of additional machinery.
2. Repairs on additional machinery.
3. Less cost per ton because the same force can usually operate the additional machinery and make the increased output in the same time.
4. The meal can be got in the market for the current year instead of part of it having to be carried over to another season.

By having ample mill capacity as against large storage capacity and working seed practically as fast as received, banking facilities become a much simpler matter and in all respects the manufacture is facilitated and cheapened.

It is a good rule in any manufacturing to keep on hand the least raw material necessary for regular running, and to sell products about as they are ready for the market. To accumulate raw material is to speculate in it, and to hold the products is equally speculative, and a factory is not necessary to speculate. Accept whatever profit there is in manufacture at current market prices of raw material and products, and when at current market prices there is no profit, shut down and wait for one or the other of the markets to change. By this plan it is always easy to determine what a factory can afford to pay for raw material.

Whenever a mill is not in condition to operate, by being unfinished or otherwise, it is especially dangerous to accumulate seed. If it seems desirable to purchase them, they should be bought and sold as a mercantile transaction, but not held to wait completion of mill, if new, or repairs, if old.

LIST OF COTTON SEED OIL MILLS IN THE SOUTH.

The following list of the active and abandoned cotton seed oil mills in the South has been compiled with a great deal of care, and it is presented as accurate and reliable. When obtainable, the capital and capacity of the mills are given:

ALABAMA.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Eufaula	Eufaula Oil and Fertilizer Company	30	$300,000
Gadsden	Etawah Alliance Company	10	.....
Montgomery	Southern Cotton Oil Company	200	S.C.O.Co.
Montgomery	Montgomery Oil Works	60	.....
Montgomery	Alabama Oil Works	60	Trust.
Opelika	M. T. Trawick	20	20,000
Selma	Central Oil Company	100	Trust.
Troy	Troy Fertilizer Company	30	60,000
Tuskaloosa	Tuskaloosa Oil Company	30	35,000
Union Springs	Bullock County Manufacturing Co.	30	25,000
Woodley	Walter Bros.	12	10,000

List of Abandoned Mills.

Location.	Name of Mill.	Capacity, Tons.	Year.
Macon	Marion Oil Company	.....	.....
Tuskegee	Tuskegee Oil Company	20	1883
Union Springs	Union Springs Oil Company	30	1884
Eufaula	Eufaula Oil Company	30	1884
Mobile	Gulf City Oil Company	40	1884

ARKANSAS.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Argenta	Argenta Oil and Compress Company	150	Trust.
Brinkley	Brinkley Oil Company	100	Trust.
Fort Smith	Fort Smith Oil and Compress Co	100	Trust.
Helena	Anchor Oil Company	100	Trust.
Helena	Planters' Mill	.....	.....
Little Rock	Southern Cotton Oil Company	200	S.C.O.Co.
Pine Bluff	Emma Oil Company	60	Trust.
Texarkana	Arkansas Oil and Compress Co	100	Trust.

List of Abandoned Mills.

Location.	Name of Mill.	Capacity, Tons.	Year.
Little Rock	Little Rock Oil and Compress Co	100	1889
Newport	Newport Oil and Manufacturing Co.	60	1882
Texarkana	Texarkana Oil Company	80	1883

FLORIDA.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
High Spring	G. M. Whetstone	15	$15,000
Madison	Florida Manufacturing Company	20	40,000

GEORGIA.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Albany	Albany Oil and Refining Company	45	Trust.
Americus	Americus Oil and Guano Company	30	$40,000
Athens	McGinty & Hunnicut	12	10,000
Atlanta	Southern Cotton Oil Company	200	S.C.O.Co.
Atlanta	Gate City Oil Company	150	200,000
Atlanta	Atlanta Oil Company	120	Trust.
Augusta	Augusta Oil Company	50	Trust.
Columbus	Muskogee Oil Company	50	Trust.
Conyers	Conyers Oil and Fertilizer Co.	15	20,000
Covington	Brick Store Oil Company	5	10,000
Dawson	Dawson Oil Company	10	12,000
Elberton	Elberton Oil Company	30	40,000
Forsyth	Forsyth Co-operative Mfg. Co.	20	25,000
Griffin	Farmers' Co-operative Mfg. Co.	20	30,000
Hawkinsville	Lathrop Oil Mills	20	20,000
Hogansville	Middle Ga. Oil and Fertilizer Works	15	15,000
Jackson	Jackson Oil Company	30	30,000
La Grange	La Grange Mills	30	30,000
Locust Grove	Locust Grove Oil Company	15	12,000
Macon	Macon Oil and Fertilizer Company	60	Trust.
Macon	Farmers' Oil and Ice Company	30	25,000
Madison	Georgia Farmers' Oil Company	30	35,000
Milledgeville	Milledgeville Oil and Fertilizer Co.	20	20,000
Monroe	Monroe Guano Company	20	12,000
Newman	McBride & Company	30	30,000
Rome	Rome Oil and Fertilizer Company	70	Trust.
Savannah	Southern Cotton Oil Company	100	S.C.O.Co.
Smithonia	Smithonia Oil Company	20	25,000
Social Circle	Walton Guano Company	20	20,000
Washington	Excelsior Mfg. Co. (leased)	40	60,000
Waynesboro	Waynesboro Oil Company	25	30,000
West Point	Planters' Oil and Guano Company	20	30,000

List of Abandoned Mills.

Location.	Name of Mill.	Capacity, Tons.	Year.
Thomasville	Thomasville Oil Company	20	1880

LOUISIANA.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Baton Rouge	Capital City Oil Company	80	$100,000
Conchatta	J. T. Armistead Oil Mill	12	15,000
Gretna	Union Oil Company	300	Trust.
Gretna	Crescent Oil Company	300	Trust.
Gretna	Southern Cotton Oil Company	300	S.C.O.Co.
Monroe	Union Oil Company	60	Trust.
Monroe	Planters' Oil Mill	60	100,000
New Iberia	Gates & Vesey	15	15,000
New Orleans	Standard Cotton Oil Company	50	60,000
Shreveport	Union Oil Company	125	Trust.
St. Martinsville	F. Rousseaux	30	20,000
St. Martinsville	St. Martins Oil Works	20	25,000
New Orleans	Marginnis Oil Company	100	Trust.
New Orleans	Independent Oil Company	150	200,000

List of Abandoned Mills.

Location.	Name of Mill.	Capacity, Tons.	Year.
New Orleans	Bienville Oil Company	60	1882
Carrollton	Carrollton Oil Company	60	1882
Baton Rouge	Baton Rouge Oil Company	50	1884

MISSISSIPPI.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Canton	Canton Oil Mills	25	.....
Columbus	Columbus Oil Mills	80	Trust.
Friar's Point	Friar's Point Oil Mill	50	$75,000
Grenada	Grenada Oil and Cotton Company	60	32,000
Greenville	Greenville Oil Works	100	Trust.
Greenville	Planters' Oil and Seed Association	30	30,000
Jackson	Capital City Oil Company	75	50,000
Meridian	Meridian Oil Mills	150	Trust.
Natchez	Adams Manufacturing Company	60	100,000
Port Gibson	Fort Gibson Oil Works	50	75,000
Rodney	Rodney Oil Mill	30	.....
Vicksburg	Vicksburg Cotton and Oil Mill	60	.....
Vicksburg	Refuge Oil Mill	90	125,000
West Point	West Point Oil Mill	50	.....
Yazoo City	Yazoo Oil Works	72	50,000

List of Abandoned Mills.

Location.	Name of Mill.	Capacity, Tons.	Year.
Clarksdale	Sunflower Oil Company	60	1884
Vicksburg	Hill City Oil Company	50	1884
Natches	Carpenter & Dick	30	.....

NORTH CAROLINA.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Battleboro	Swift Creek Manufacturing Co	10	$12,000
Charlotte	Charlotte Oil & Fertilizer Company	140	200,000
Charlotte	Oliver Oil Company	60	Trust.
Conetoe	Conetoe Oil Company	20	15,000
Elizabeth City	Elizabeth City Oil Company	30	30,000
Fayetteville	Fayetteville Oil Company	40	30,000
Goldsboro	Goldsboro Oil Company	40	35,000
Gibson Station	State Line Oil Mill	60	.....
Gibson Station	Gibson Oil Company	10	25,000
Laurinburg	Laurinburg Oil Mill	60	.....
*New Berne	New Berne Oil Company	10	25,000
Raleigh	Raleigh Oil Company	75	Trust.
Rowland	Townsend & McQueen	10	12,000
Tarboro	Farmers' Manufacturing Company	30	50,000
Tarboro	Tarboro Oil Company	30	40,000
Washington	Myers Cotton Oil Company	10	12,000
Wilmington	Wilmington Oil Company	60	Trust.

* Burned and rebuilding.

SOUTH CAROLINA.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Abbeville	Abbeville Oil and Fert. Company	30	30,000
Allendale	Allendale Oil Mill	10	.....
Anderson	Anderson Oil and Fertilizer Co	25	30,000
Barnwell	Barnwell Oil and Fertilizer Co	25	40,000
Belton	Belton Oil Mill	20	17,000
Bennettsville	Marlboro Oil Company	30	35,000
Columbia	Southern Cotton Oil Company	100	S.C.O.Co.
Columbia	Oliver Oil Company	100	Trust.
Darlington	Darlington G. M. & F. Company	25	35,000
Dillon	Dillon Oil and Fertilizer Company	15	25,000
Easley	Easley Oil Company	10	15,000
Edgefield	Edgefield G. M. & F. Company	10	15,000
Florence	Florence Oil and Fertilizer Co.	20	30,000
Greenville	Greenville Oil and Ice Company	60	Trust.
Greenwood	Greenwood Oil and Fertilizer Co	25	30,000
Laurens	Oil and Fertilizer Company	30	30,000
Marion	Marion Oil Mill	25	40,000
Newberry	Newberry Oil Company	15	25,000
Ninety-six	Ninety-six Oil Company	15	20,000
Orangeburg	Orangeburg Oil Company	20	30,000
Ridge Spring	Ridge Spring Oil Company	15	30,000
Rock Hill	Cochran Oil Company	30	25,000
Seneca	Seneca Oil and Fertilizer Company	10	30,000
Spartanburg	Produco Mills	85	50,000
St. Matthews	St. Matthews Oil Company	15	25,000
Union	Union Oil and Manufacturing Co.	20	15,000
Wateree	Wateree Oil Mills	10	12,000
Winnsboro	Fairfield Oil Company	15	.....

List of Abandoned Mills.

Location.	Name of Mill.	Capacity, Tons.	Year.
Columbia	Columbia Oil Company	15	1890
Chester	Catawba Oil Company	30	1885
Charleston	Charleston Oil Company	60	1884

TENNESSEE.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Dyersburg	Dyersburg Oil and Fertilizer Co.	25	20,000
Jackson	Jackson Oil Mills	60	30,000
Memphis	*Columbia Oil Company	.....	.....
Memphis	Southern Cotton Oil Company	200	S.C.C.Co.
Memphis	De Soto Oil Company	100	150,000
Memphis	Valley Oil Mill	100	150,000
Memphis	Chickasaw Refining Company †	.....	Trust.
Memphis	*Star Oil Mills	100	125,000
Memphis	Gayaso Oil Mills	60	130,000
Memphis	Globe Oil Refining Company	60	Trust.
Memphis	Hanover Oil Company	100	Trust.
Msmphis	Planters' Oil Company	150	Trust.
Memphis	*National Oil and Huller Company	.....	.....
Memphis	†Tennessee Oil Company	.....	Trust.
Nashville	Nashville Oil Company	.....	Trust.
Trenton	Trenton Oil Company	20	30,000
Memphis	*Diamond Huller Company	.....	.....

* The Diamond Huller Company, the National Oil and Huller Company, the Columbia Oil Company, and the Star Mills are associated companies, organized to undertake to introduce a system of hulling seed in the country, at farms, and handling meats only, leaving hulls on the farms.

† The Tennessee Oil Company owns the stock of the Trust mill in Tennessee.

TEXAS.

List of Active Mills.

Location.	Name of Mill.	Capacity, Tons.	Capital.
Belton	Belton Oil Company	40	$60,000
Brenham	Brenham Oil Company	40	60,000
Bonham	Bonham Oil and Cotton Company	25	30,000
Cuero	Cuero Oil Company	70	75,000
Caldwell	Caldwell Oil Mills	10	15,000
Cameron	Milan County Oil Mill	10	15,000
Galveston	Nat. Oil Company	60	Trust.
Gainesville	Gainesville Oil Company	.....	.....
Greenville	Greenville Oil Company	20	35,000
Hempstead	Hempstead Oil Company	10	12,000
Hallettsville	Hallettsville Oil Company	20	30,000
Honey Grove	Honey Grove Oil Company	35	40,000
Luling	Luling Oil Company	10	15,000
Houston	National Oil Company	300	Trust.
Houston	Southern Cotton Oil Company	300	S.C.O.Co.
Houston	Merchants' and Planters' Oil Co.	200	250,000
Moulton	Moulton Oil Company	10	15,000
Navasota	H. Schumacher	40	50,000
Schulenburg	Schulenburg Oil Company	10	15,000
Sherman	Sherman Oil Company	100	200,000
Paris	Paris Oil and Cotton Company	130	150,000
San Antonio	San Antonio Oil Company	20	25,000
Sulphur Springs	Sulphur Springs Oil Company	30	35,000
Waco	Waco Oil Company	50	.....
Wolf City	Wolf City Oil Company	30	35,000
Weimer	Weimer Oil Company	20	20,000

List of Abandoned Mills.

Location.	Name of Mill.	Capacity, Tons.	Year.
Austin	National Cotton Oil Company	60	1884
Belton	Belton Oil Company	40	1884
Columbus	Colorado Oil Company	40	1885
Corsicana	National Oil Company	50	1883
Dallas	National Oil Company	100	1884
Jefferson	Phœnix Oil Company	60	1885
La Grange	La Grange Oil Company	50	1884
Pari	Paris Oil Works	50	1883
Palestine	Nat. Cotton Oil Company	60	1884
McKinney	Colin County Oil Company	30	1883
Tyler	Tyler Oil Works	30	1883

[Continued from SUPPLEMENT, No. 829, page 13250.]

THE DECORATIVE TREATMENT OF NATURAL FOLIAGE.*

By HUGH STANNUS

Lecture II.

§ 10.—REALISM: COMPLETE.

IN the Complete or Pictorial Realism: the Chief object is represented with the utmost fidelity to the actual appearances. The Growth is drawn from the individual branch, in all its accidents of malformation, abnormal growth, or mutilation; the positions of leaves and flowers are rendered without regard to the *mass-shape* of the whole, or the *foreshortening* of portions; and the Light-and-Shade, and the Local-Color, with Reflections and Accidental-lights, are included; making the painting a perfect Portrait of the chosen object. The Surroundings or Foreground-objects (if any), and the Background (be it landscape or otherwise) are also included; making the whole a complete Picture. It might be painted on a Furniture-panel, without the regulation gilt Frame: it would still be a Picture.

An example of this might show a group of Flowers in a Vase, placed under an Arch, through which is seen a Landscape background. In this, it would be observed that:—(1) the whole is in perspective, and that the Point-of-sight is not on the axis or center-line of the picture; (2) the Chief-object (the Flower-vase) is not axial in position; (3) the Vase is not parallel to the Picture-plane, as shown by the handles and plinth; (4) the Flower-mass is not axial with the Vase, but leans over on one side; and (5) a portion of the Flowers is cut-off by the window-opening. Each of these treatments is contrary to the usually-accepted Canons of Decorations; and the combination of them is appropriate to the Realistic or Pictorial Method. All Pictures are executed in this method.

§ 11.—REALISM: SEMI-PICTORIAL.

In this second treatment the Chief-object and the Foreground-surroundings are still as realistically represented as in the first, except that malformation and abnormal growth are omitted; but the Background is reduced from realism to the Conventionalism of a Flat-tint of color (including gilt or similar grounds in this category). Hence the painting is still a perfect Portrait of the chosen objects; but it is not a Picture. It might be painted on canvas and placed in a gilt frame: it would still be something less than a Picture, and would lie in the borderland between the Pictorial and Decorative Arts.

An example of this might show:—(1) The whole to be still in Perspective, but the Point-of-Sight is now in the axis of the window-opening; (2) the Chief-object is axial in position; (3) the Vase-plinth, etc., are parallel; (4) the Flower-mass is almost axial and symmetrical; and (5) no portion of the subject is cut-off by the Window-opening. Much of the more elaborate Mural-decoration (in Painting and in Tapestry) is executed in this method.

§ 12.—REALISM: DECORATIVE.

In this third treatment, the Chief-object (*only*) is realistically represented, as in the two preceding; but everything else is reduced, in character, to a Conventional representation. It will be observed that the Chief-object is the sole survivor of the Realism. This is a "Survival of the Fittest;" and it is obvious that if the higher treatment be retained—it should be applied to the higher object. Realism is very appropriate and effective, in this manner, imparting an added charm to Decorative work; serving (so to speak) as the Jewel of the setting, or the Focus of the composition. It can never raise the work to be Pictorial; it might be painted on any surface: it would still be Decoration.

An example of this might show:—(1) There would be no Perspective, but everything would be in Elevation; (2) the Chief-object is axial as in the second; (3) the Vase is severely drawn in elevation; (4) the Flower-mass is axial as before; (5) no portion is cut-off; and (6) the Arched-opening is replaced by a Color-margin which is separated or divided from the inner panel by a thin tendril of Artificial Foliage (as in Louis XVI. work). Most of the more elaborate foreign Furniture-coverings in Brocade-silk and Tapestry are from designs executed in this method.

It will be observed that there is—corresponding to the gradual reduction of Realism—a gradual increase in Artificial arrangement. Thus the position and attitude of the Vase, and the mass and grouping of the Flowers, become gradually more severe as the work gradually loses its Pictorial character.

§ 13.—APPLICATION OF REALISM.

Realistic representations have their place in the following Positions and Objects: (*a*) Important positions, *e. g.* the center of a Wall, or a Cabinet; (*b*) Non-functional portions of objects, *e. g.* panels; (*c*) Movable objects, *e. g.* Pictures; and unfolded Drapery, *e. g.* Tapestries, and figured Brocade-silks whose evident cost is an excuse for their aim at Realism, and will also prevent their being lavishly applied, etc.

Realistic representations, in any of the three degrees of realism, should be *unical*, *i. e.* should not be repeated in the same design. When there is Repetition, and it is produced *by hand*, *e. g.* in Embroidery—it would be treated in the second or third degree of realism; and more effort to imitate the appearance of Nature would be allowed, because the details would be each individualized and all varied by the Worker.

When, however, the repetition is mechanical—the details should be generalized. If the spectator were to observe a highly realistic portrait of a flower on a wall; and, a few inches distant, see another, exactly similar in every respect; and so on all over the wall—his attention would have been raised for nothing; and he would be disappointed. The example, Fig. 6 is one of the best and least objectionable of these. It is only a matter of regret that a clever Artist should occupy his talent in the effort to make a repeating Print emulate a water-color Picture.

§ 14.—CONVENTIONALISM.

In the absolute or Ultimate Conventionalism: the whole of each object is represented in Outline (*only*). There are, however, Degrees in this reduction, from the Complete Realism of § 10 to the Absolute Conventionalism of § 18, corresponding to the reduction in the available appliances; and these are shown in the Chart in § 9.

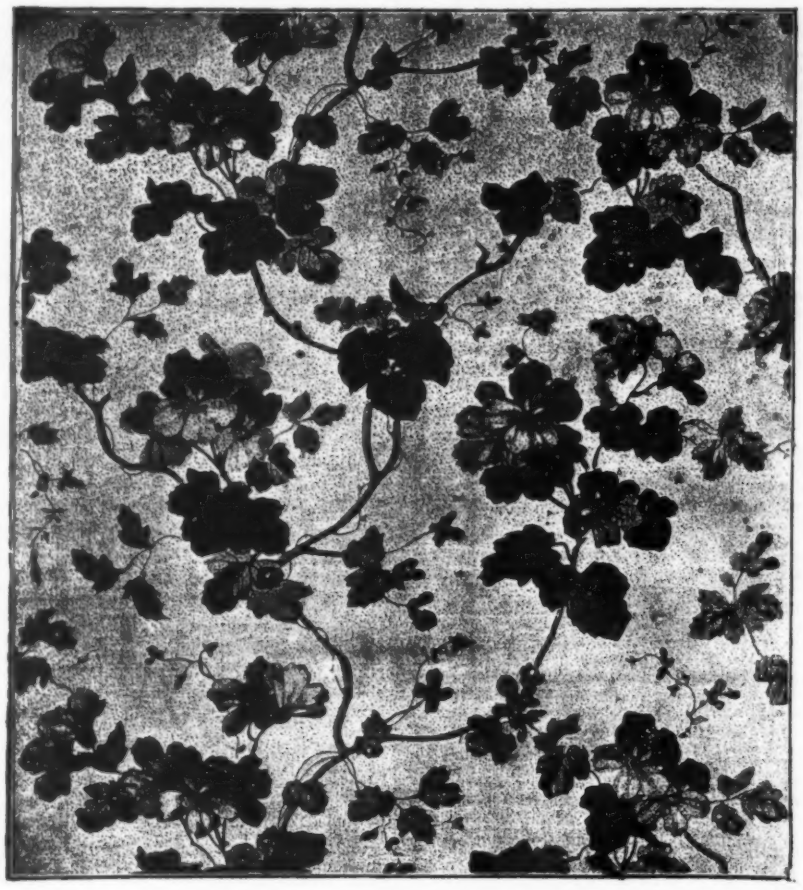


FIG. 6.

The Student has doubtless read of some early Levantine Trader being met, on his return voyage, by a continuous spell of tempestuous weather, who casts overboard successively, portions of his cargo in endeavoring to make the port with the remainder—how in the Mediterranean, he throws overboard his heavy tackle—by Gibraltar, the dried fruits—in the Bay, his Coffee—in the Channel, the Embroidery—and by the Goodwins, the Silks—the Sapphires and Rubies being the sole surviving results of his venture. So he can imagine the Decorative-artist losing in succession his Appliances—how he cannot execute his work by his own hand, but must trust to others—he cannot have hand-work, but must trust to mechanical reproduction—he cannot have all the varied colors of Nature, but is reduced to a limited number—he cannot give varied color, but only monochrome gradation—he cannot give gradation, but only flat-tint—the Outline being his sole surviving servant.

With this gradual "throwing-overboard of the Cargo" or lessening of Appliances—two results ensue:—(i) On each lessening of his Appliances, the student will make *less ambitious* efforts; (ii) on each loss of any Appliance or method of expression, he will develop

FIG. 7.

FIG. 8

* Lectures before the Society of Arts, London, 1891.

more acutely those which yet remain. It is observed, in the domain of Sensation, that those who have lost Sight become more acute in Hearing and Touch: so also in the domain of Art the absence of complete Realism is compensated by accentuation of the Characteristics; and the loss of Color or Light-and-Shade is replaced by clearness in the Drawing (see § 18).

§ 15.—CONVENTIONALISM: FIRST DEGREE.

The first degree of Conventionalism results from either of the two restrictions in available appliances shown in the Chart at § 9.

FIG. 9.

Of the former loss (*a*)—in the number of available pigments—some of the Japanese pictures are good examples. In one such, the Artist has been limited to three Pigments—Black, Gray, and Fawn—with which he has represented a Bird in Water among Flag-Lilies. He has shown the Bird with Gray and Buff, using the Black for his eye, beak, and heightening touches; in the water, and leaves, Gray is chiefly used; and the flowers are represented in Black, with buff penciling. This is a very characteristic example: the Artist was probably impressed by the striking effect of the strong Blue of the flowers, as the *most important* feature of the whole; and he used his Black (a nearly related

FIG. 10.

pigment) as the best substitute that was available. This is not Realism, inasmuch as Black is substituted for Blue; but it is good Conventionalism.

Other examples of working with a restricted palette are found in Majolica-ware. There the available pigments were a matter of Chemistry; and the only ones then at the disposal of the Potter were a Blue, the two tints of Siena, a Green, a Black, and the two Lusters of Maestro Giorgio.

In the latter loss (*b*)—of Gradation and Shading, the flat tints of Pigments only being available—most of the Wall-papers used in houses are good examples. In studying them, it will be observed that when the Artist is reduced to Flat-tints of colors, his ingenuity is taxed to give the necessary Clearness. In the simplest

FIG. 11.

method of using flat-tints (*i. e.* the Blot-method) he might use different tints for the different parts of the plant:—*e. g.* a pink for the flowers, a green for the leaves, and a brown for the stems. This, while it would give the general shape or mass of each part, would be found inadequate to give the inner drawing and details; as may be seen in Fig. 7.

The leaf may therefore be represented as in Fig. 8, *i. e. in separate pieces* with the ground showing-through. It might be objected—that the real leaf is not in separate pieces: but to this it would be replied that—when judiciously done, the eye takes-in the several parts as one whole; and that this is one of the concessions to technical limitations which are the truest Conventionalism.

The ground which shows through between the separate parts of a leaf, will be seen to vary in breadth. When it represents the Veining of a leaf or the Penciling of a petal—it is narrow and tapering, for the purpose of suggesting the relative breadths of Nature. When it gives the drawing of different portions of the same leaf, *e. g.* when the leaf turns over—it is rather wider. When it separates one leaf from another, or one part overlapping another, it is still wider, as shown in Fig. 11. This method of showing the ground between the parts, is termed "Voiding," from the practice in Heraldry.

Two flat tints may be effectively used, as is shown in Fig. 9, in which the first tint gives the Mass blot, as in Fig. 7; and the second tint gives Local color or Shadow. This second tint must be so disposed as to assist the drawing by making dark portions of one leaf against light portions of another. The second flat tint may also be used to give Texture on the fruit, flower, leaf or stem.

Another manner of using two tints for Leaves, is suggested by the Japanese. In Nature the upper sur-

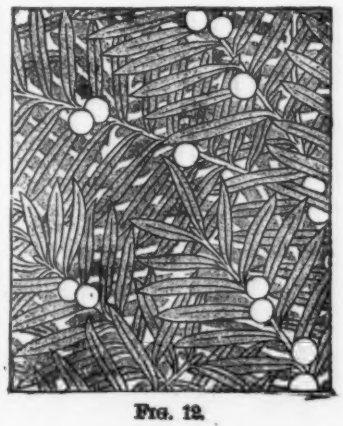


FIG. 12.

face of a leaf is nearly always shiny, and of a darker green than the under surface, which is gray and dull. This is admirably shown in Fig. 10, in which the shiny and dark upper surface is represented by a black blot, with voided veins, and the under surface by a gray blot, with outline veins.

The Outline, which in ultimate Conventionalism is the sole survivor, is often very useful when superadded in the intermediate degrees, not only for Clearness of drawing and Distinctness of pattern, but for Color and Breadth. A yellow outline adds luminosity, a pink or light blue one adds a bloom, and a brown one adds a somber tone. Each of these is valuable in its place, and an outline of the proper tint will often harmonize harsh and discordant colors, and thus give Breadth and Softness to the whole. An outline, of any tint, has the effect of *attaching* the pattern to the ground, thus giving Steadiness, and, further, of recognizing the Surface, as is shown in Fig. 11.

Sometimes, when there are *two planes* of foliage in a pattern, the foliage in front is outlined, and that in the rear is left in the blot, as is shown in Fig. 12.

§ 16.—CONVENTIONALISM: SECOND DEGREE.

The second degree of Conventionalism results from either of the two restrictions in available appliances shown in the Chart at § 9.

FIG. 13.

Of the former reduction (*c*)—to gradated Monochrome in Colors—some of the painted Fans are good examples. In one such, the Artist, working on a ground of Black silk, has represented the principal

FIG. 14.

group of Flowers in realistic colors; but those which are on each side are represented as gradually fading, or "*losing color*," until those at the extreme end are painted in tints of gray monochrome. The Light and shade and the Gradation of tone are kept; but, the color being *lost*, the effect is Conventional. In another such Fan, the ground being Red, the side flowers

FIG. 15.

FIG. 16.

gradually "lose" their proper colors, until they are represented in Red monochrome. In both of these instances the fading is toward the Monochrome scale of the Ground color. It will be observed in the given instances that the particular treatment has been adopted, not from technical, but from *æsthetic* considerations, as an artistic modulation to the color of the ground.

This practice often occurs in Decorative painting, in which the different portions are represented in monochrome scales of different colors; and also in chintz patterns, in which the so-called "Autumn tints" are often used. Sometimes tints which are accurate in regard to Gradation are arbitrarily substituted for the natural colors. This often arises from the Artist's sense of inability, with a restricted palette, to emulate the beauty of Nature—a failure which is less apparent in the *arbitrary* than in the natural colors.

Sometimes in Diapers on Wall papers the pattern is *Duplex*, *i. e.*, there is a front pattern in strong coloring, and a separate Rear pattern in softer coloring. In these cases the color of the Rear pattern is often printed in a darker tone of the ground color, or some intermediate tint between that and the colors of the Front pattern. This is an analogous case of modulation to the Ground color.

Of the latter reduction (*d*), to gradated Monochrome in Black and White, most of the Limoges enamels are good examples.

It has not been practicable, owing to absence of color in the reproduced illustrations, to give examples of these; but the Student may see many in the Museums.

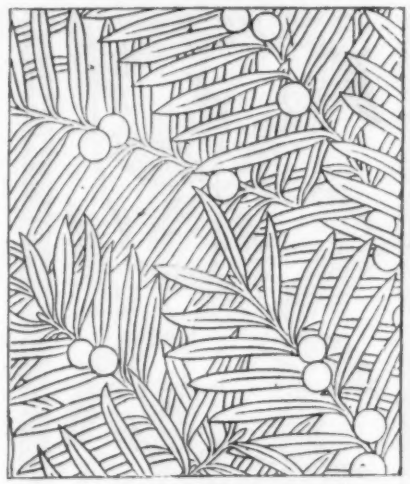


FIG. 17.

§ 17.—CONVENTIONALISM: THIRD DEGREE.

The third degree of Conventionalism results from the further restrictions in available appliances shown in the Chart at § 9.

The two restrictions—(*e*) to one flat Mass tint on a ground of another flat tint, or (*f*) to a black Mass tint on white—have, practically, similar results; and the same treatment, so far as Conventionalism is involved, may be applied to both.

A pattern in the third degre of Conventionalism is given in Fig. 13. It will be observed that all parts of the plant—fruit, leaves, and stems—are in one flat tint or Mass blot, which has a somewhat dull effect.

Variety of appearance, and nearer approximation to Nature, may be produced by combining the two methods—of the Mass blot and the Outline—as shown in

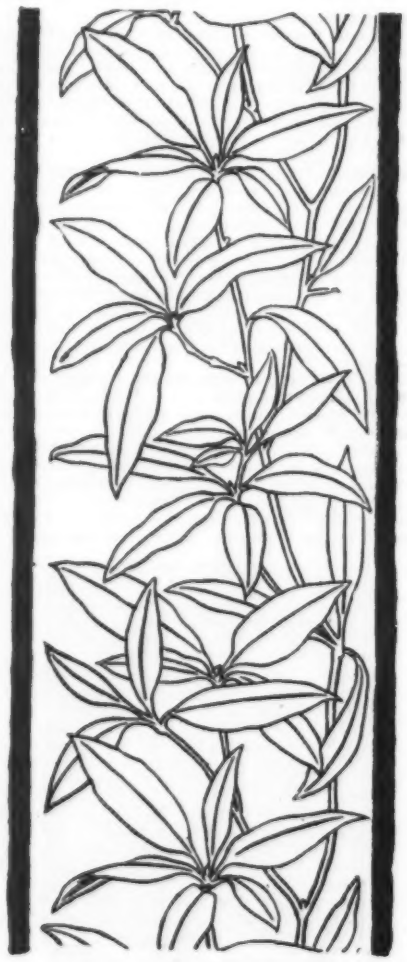


FIG. 18.

FIG. 19

Fig. 14. In such a treatment, the Flowers or Fruit should be represented by one method, and the Leaves and Stems by the other.

The particular method to be adopted depends on the local colors of the Plant and that of the available Flat

tint. When the Pomegranate is used, the local colors are yellow for the Fruit, and green for the Leaves and Stems. If, therefore, the available Flat tint be *yellow*, then the (yellow) Fruit should be in mass blot, and the (green) Leaves, etc., should be in outline, as shown in the upper half of Fig. 14. If the available Flat tint be *green*, then the (green) Leaves, etc., should be in mass blot, and the (yellow) Fruit should be in outline, as shown in the lower half of the diagram. The difference will be observed on comparing Fig. 14 with Fig. 13.

Generally, the relative tone of Flower or Fruit with Leaf, and the Flat tint which is to represent them, must be all considered with reference to each other and to that of the Ground color.

When the Leaves, in dark mass blot, can be arranged to lie in part behind the outlined Flowers, then they will serve the purpose of "forcing up" the brightness of the Flower, and making it to appear brighter than the ground, though of the same tint, and thus more effective.

The foregoing designs are reproduced *positively*, *i. e.*, the pattern is *added* to the ground. Occasionally, designs are reproduced *negatively*, *i. e.*, the pattern is *cut out* of the block which prints the ground, and is thus voided, as is shown in Fig. 15.

This Negative method is an addition to the resources of the Pattern-artist. It may be combined with the Positive method; and produce a good result; as is shown in Fig. 16.

§ 18.—CONVENTIONALISM: ULTIMATE DEGREE.

The fourth and ultimate degree of Conventionalism results from the severe restrictions in available appliances shown in the Chart at § 9. These two restrictions—(*g*) to Outline of several colors, and (*h*) to Outline of one color (*only*)—bring the pattern-artist to his last resources. To Outline, as the last survivor, must he trust for his effect; and here the necessity of careful study, in order to compensate for the loss of all else, as mentioned in § 14, is most strongly felt.

Of the former reduction (*g*)—to Outline in *several* tints—the "Homeric Marbles" at University College are a well-known example. Here the drawing of the various figures is engraved or incised on various pieces of marble, and the lines of hair, drapery, etc., are filled in with different colors, giving great clearness. Most of the beautiful Leek embroidery is outline (*only*) in various colors. These lines of veins, etc., give the effect of a *Tint*, by the Suffusion of the color-of-the-lines over the ground, as mentioned in the Theory of Coloring.

Of the latter reduction (*h*)—to outline in one tint—the so-called "Flaxman Outlines" to the Iliad are a well-known example. Fig. 17 shows an impression of the Outline-block of the pattern given in Fig. 12. It was not designed as an "*outline pattern*" (*i. e.* one in which the outline is the *only* means of producing the pattern), but as the outline of a tinted pattern; hence it is not so carefully considered and developed as in Fig. 19, which is for *outline only*.

In Outline-work the Student should search for and emphasize the difference in drawing between the different parts of the plant. He may exaggerate the serrated edge of the Leaf, to distinguish it from the delicately undulated Petal-edge. Departure from the Reality is condoned if the pattern be good. It should be borne in mind that the end is—not a Botanical diagram, but—a Pattern. There are, however, degrees in the amount of this exaggeration; and if it be detected, then the Student should remember that the Spartan boys were punished, not for the theft, but—for their clumsiness in being found out.

Variety in breadth of the Outline is another resource yet remaining to the Artist. There are other qualities of line, *e. g.* Texture; but they are scarcely amenable to the severity of ultimate Conventionalism. With the help of varied breadth, however, a clear and artistic effect may be produced, even in outline.

There are two systems by which the variety-of-breadth may be regulated:—(i) The Light-and-shade system, under which—a weak line was used on the light side or edge of objects, a medium line on the side parallel to the picture-plane, and a strong line on the darker side or edge. It was much used in Architectural and Engineering drawing twenty years ago, and was termed "Back-lining;" but has latterly been discontinued; it is a vicious system, and an attempt to achieve more (*i. e.* Light-and-shade) than the available Means (*i. e.* outline) will permit. (ii) The Mass-line system, under which—a weak line is used for those objects which are farthest from the spectator, and a strong line for those objects or parts of objects which are nearest, in direct ratio to distance or nearness; this with the further development from it—of drawing the mass-line (or line which circumscribes each mass or object) a little more strongly than the inner lines of that particular mass, each being graduated according to the distance or nearness—was systematized by the writer about twenty years ago. Fig. 18 shows a design in which the outline is all of approximately *the same breadth*; and Fig. 19 shows the same design with the foremost leaves *mass-lined*; it will be obvious that the latter is the more effective.

§ 19.—NOTE ON CONVENTIONALISM.

The Student will perceive that Conventionalism lies—not in changing the natural growth to some preconceived idea of his own, but—in rendering all the beauty which is possible with the limited technical means at his disposal.

Also that the expression—"conventional foliage" is as meaningless as the other—"natural representation;" the correct statement being that the *kind* of foliage is "natural" or otherwise, and the *method* of representation is "conventional" or otherwise.

He will further perceive that *limitation* of Means does not necessarily involve *stiffness* of Attitude; though some have so associated the two ideas that the word "conventional" has fallen into bad repute. With all the loss and restriction of Means, there will always remain the power to DRAW; and thus to endeavor, however insufficiently, to utilize some of that infinite wealth of Beauty which lies around.

SIBLEY COLLEGE LECTURES.—1891-92.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

I. — FIRE HAZARDS FROM ELECTRICITY.*

By C. J. H. WOODBURY, of Boston, Mass.

ONE of the many innovations arising from the introduction of electric lighting has been the development of a new feature in underwriting, which is the beginning of methods of practice which will in time greatly modify systems of insurance.

There have been two methods of dealing with questions involving the insurance of elements of unusual hazard; the one being that of underwriting pure and simple, estimating the hazard from the best data at hand and charging a rate commensurate with that risk; the correct principle being that the hazard of the whole is equal to the greatest hazard of any part of the risk.

The other method has consisted in eliminating the hazard of the more dangerous parts by removing such processes to another building, or at least placing them in a portion of a building where the chances of their imperiling the whole would be controlled by special methods of construction and also by additional fire apparatus, or in other words, bringing the hazard to conform to the rate of insurance.

The latter method is confined to class insurance of such limited range that the detailed supervision of risks can be within the personal scope of the administration of such insurance companies.

When electricity was first used for lighting on a commercial scale, no small part of the knowledge gained of phenomena was the fact that it became a frequent cause of fire, and in such unexpected ways that a general alarm ensued which would have stopped its use if electric lighting had not so completely filled a need for more light that a prohibition was out of the question. Electricity had come to stay, and the problem of its status must be met and not evaded.

Those whose familiarity with electrical lighting appliances is only that of to-day, with every element of the apparatus established in commercial affairs, can have but little appreciation of the condition of such matters a little over ten years ago.

Everything was new, crude, and undeveloped. The leading inventors were pursuing their investigations under great difficulties, not the least of which was the lack of trained assistants. Mechanics had much to learn in the construction of the apparatus, the proper manufacturing supplies were not in the market, and the steam engines especially designed for operating dynamos had not been made. The development of the whole business required invention, education, and organization from one end to the other.

Electric lighting then pertained to apparatus for the physical laboratory; now it is one of the great commercial features in the business world, reaching in all its applications in the United States to investments estimated by Lieut. Allen R. Foote, special agent United States Census, to be $232,202,850 out of a total of $552,202,850 invested in electrical enterprises, and divided as follows: Telegraph companies, $125,000,000; telephone companies, $100,000,000; isolated lighting plants, $6,000,000; central station plants, $155,202,850; electric railways, $70,000,000; fire alarm and police patrol, $10,000,000; steamboat plants, $1,000,000; sundry industries, $10,000,000; manufactures, $75,000,000.

The introduction of electric lighting in this country was followed by numerous fires caused by this new method of illumination. After the disturbance incident to the first scare, careful investigations were made into the subject, the greatest result of which was the establishment of the opinion that the elements of excessive hazard were not necessarily inherent in such applications of electricity. In other words, such fires were to be classed as preventable fires within the limits of ordinary practical means; and on this basis the rules for electrical installations were first prepared, only to be followed by other rules, drawn up by various parties, to apply to new conditions for the use of electricity for the transmission of power and alternating currents, as well as to improvements in both arc and incandescent lighting.

The electric lighting interests have always and without exception co-operated with the underwriters in these investigations, which indeed could not have reached to successful results had it not been for the indispensable services afforded by the skill of those engaged in this manufacture.

The results have fully justified the means, for electricity is to-day the safest method of artificial illumination. This safety is not due to the absence of possibilities of danger, but to the entirety with which these elements of danger may be held in control.

The essentials of safety consist in confining the electricity to its metallic circuits, the prevention of undue arcs in switches and lamps, and the prevention of sparks or carbons falling from arc lamps; but in their applications these precautions are necessarily involved in order to meet all of the complex conditions of the apparatus used in the various applications of dynamo currents.

The danger of fire from dynamo currents is almost entirely due to the diversion of a portion of the electricity from the system, and to the fact that the miscellaneous conductors forming these outside circuits are not adequate to convey the current without undue and dangerous heating. Moisture on an otherwise poor conductor generally plays an important part in such conversions of electricity into heat, because the small trickling of water is readily dissociated and then the resistance at the place is increased to a sufficient amount to cause the electricity to be converted into heat of sufficient temperature to ignite any combustible material in its path.

Rain water, or that from ponds used for a public water supply, is a rather poor conductor, but in passing over whitewash it takes enough salt and lime into solution to become a very fair conductor, and the same applies to water used in washing floors.

About ten years ago I made some experiments upon this matter for the purpose of investigating into the the conditions of two fires caused by arc lighting circuits.

From the binding posts of an arc lighting dynamo with forty lights in circuit, two wires about six feet in length were secured one foot apart upon a broad board, thus providing the greatest difference of potential in the circuit, amounting to about two thousand volts, in a place where it was convenient for experiment. The board was washed with a clean mop wet with pure water, but without producing any effect. Then a little salt was thrown into the water, and the water was rapidly dissociated and evaporated, and the board set on fire, not merely on its surface, but well into its interior.

These matters are cited in advance of their proper place, for the purpose of presenting the importance of protecting a system in buildings from exposure to water, and also the urgency of keeping the system free from electrical connection from the earth; for while it is a rare coincidence that a single conductor should connect two wires of opposite polarity, yet, if one ground exists, any second connection to earth will establish an outside circuit.

A few months ago an electric lighting wire chafed against an automatic sprinkler pipe until the insulation was worn by the abrasion. The first ground already existing at some other part of the system completed a circuit, and the heat of the arc was sufficient to melt a hole in the pipe, although it was full of water.

It should be remembered that when a slight arc is formed it can be blown out as readily as the flame of a candle. This is seen in the air jets used to break the arcs on the commutator of a Thomson-Houston dynamo of the squirrel cage pattern. In the lightning arresters of the same system, the arc being diamagnetic, it is broken by the repulsion of an electro-magnet.

I wish to submit to you some of the principal considerations covering the several conditions of installations, presenting what should be considered as a consensus of the opinions of underwriters and electricians who have made a specialty of questions pertaining to the fire hazard of electricity, and these opinions are mainly based upon the experience of actual fires, or experiments in which conditions of possible hazard have been simulated.

Dynamos, generators, and motors should be considered as machines rather than merely as electrical apparatus. The shafts of the armatures should be provided with journals well suited to maintain free lubrication and to run without undue heating. The oil pans should be arranged so as to prevent any oil from being spilled on the floor, and moreover the oil should be drawn from these pans so frequently as to prevent any accumulation of oil therein.

The dynamo should rest upon substantial foundations adequate to keep it from jarring, and if used to generate currents at a tension of over 350 volts, there should be a space under the floor, as that is about the only means of preventing the attendants from receiving severe shocks if there should be a ground on the circuit.

Dynamos should be protected from exposure to water, and for this reason it is generally unadvisable to place automatic sprinklers over a dynamo room, as a discharge of water from any of these might cause a great deal of injury. Each dynamo should be provided with a waterproof cover, which is to be placed over it when not in use.

The use of motors and dynamos for trolley systems of street car propulsion introduces special features which must be provided for. In the present state of the art the single trolley wire with a return current through the earth is the only feasible means of operating an electric system of street car propulsion; and the question of the extra hazard of the motors must be met by placing the generators in special buildings, and thoroughly protecting the system of overhead wires by suitable guard wires.

The reason why the double trolley wire system is not practically effective is due to matters pertaining to mechanical questions, such as the difficulty in arranging switches and also the necessary complexity of the double trolley in comparison with the single trolley.

The single trolley system is not advocated, as has been alleged, on account of any economy of copper wire, because, in order to insure ground returns of low resistance, copper wires are buried between the tracks the whole length of the line, and connected to each rail by branch wires riveted to the web and soldered to the buried wire.

One of the more recent applications of electricity for illumination is the use of alternating currents in connection with transformers or converters. This apparatus should be situated in a secure place outside of the buildings, except in case of underground service, when the converter may be put in any convenient place that is dry and does not open into the interior of the building

Converters should be equipped with safety fuses at the junctions of all feeders and mains, and, furthermore, the wires of the secondary circuit should be protected against the current of the primary circuit from reaching the interior of the building by the use of air or film cut-outs connected with both poles of the wires of the secondary circuit near to the converters, in order that if there should be any direct electrical conductivity from the primary to the secondary circuit, the primary circuit would be grounded at once. These cut-outs are generally adjusted to operate whenever the current reaches a potential of 350 volts.

It is not desirable to ground permanently one of the wires of the secondary circuits, because in such case the wires have the same fire hazard as if the circuit was furnished with electricity from a dynamo, which would be diverted from the system whenever a second ground occurred; and it should also be borne in mind that the alternating currents tax an insulation more severely than a continuous or even pulsating current, and that as a practical matter the primary circuits of an alternating system conveying currents of high potential are almost always grounded.

Switchboards are a frequent cause of fire, because at these points are concentrated most of the extreme differences of potential due to the system, and arcs are frequently formed in the ordinary use of the switchboards. A switchboard should not be placed against a hollow partition or in any other place where it might readily communicate fire to the building. Thus far slate appears to be the preferable material for the construction of such switchboards, but when such switchboards conduct currents of high potential there is a

* Delivered at Cornell University, Nov. 6, 1891.

slight leakage across slate, and it is necessary that the holes should be bushed with hard rubber or other material. Switchboards should not be made in any event of plain wood surfaces, but whenever the circumstances are such that it is not practicable to use an incombustible material, an open skeleton of wood will best serve the purpose.

Whenever resistance boxes or equalizers are placed, precautions should be taken for the prevention of any accident in case they should become heated. Most of the frames of such apparatus are now made of metal, and asbestos paper is placed behind them if they are secured near to wood.

The lightning arresters should be connected to the earth outside of the building, and gas pipes should not be used in such connections. Water pipes are the best base to which to attach wires from lightning arresters.

The matter of outside wires cannot be adjusted on the basis of the electric principles involved, because the numerous difficulties arising from other features of the subject render the question still an unsettled problem. The wires for the most part are either over buildings not lighted by electricity, whose occupants, not being patrons of the lighting company, have no interest in the functions of these wires; or the wires are carried on poles along the streets, where their status pertains to the rights of the general public to the unobstructed use of the highway. These questions have not been settled, and will not be settled until there is found a way to settle them.

The matter is not helped by any such enactment as that passed by one of the States several years ago, to the effect that all wires should be under ground before November 1, 1885, or to similar ordinances passed by numerous municipalities during the last six or eight years.

It is not surprising that there should be a general opposition to overhead wires, of such a widespread and determined nature that they would have been placed underground years ago had there been any means which were feasible in every respect. The only reason for this sufferance of overhead wires has been the fact that the uses of electricity have been essential to the needs of the community.

Underground wires are no new thing. In fact, they preceded aerial wires, and nearly strangled the invention of the telegraph; for when the first line was being laid in 1843 between Baltimore and Washington, along the line of the Baltimore and Ohio Railway, subject to the conditional consent of the board of directors that "the wires should be removed in case that the electric fluid caused any injury to the property of the company," the wires, as a part of Prof. Morse's invention, were covered with an insulation, placed in lead pipes, and for nine miles, from Baltimore to Relay Station, laid underground by means of a special plow invented by Ezra Cornell. This line did not work, and Ezra Cornell made the invention, which expanded the telegraph from an apparatus to a system, by placing the wires overhead attached to insulators at points of support.

Since that time ingenious inventors have endeavored to devise methods for running the wires underground, without producing anything practical except to a limited extent, and not feasible in any event except in densely populated localities where the patronage is sufficient to permit the excessive expense.

All must recognize the great work of Edison in his invention of an underground system adapted to his system of electric lighting.

One of the pioneer efforts to devise an underground system fitted to American practice in arc lighting was that of Prof. W. A. Anthony, who laid wires under the Campus at Cornell University in 1878, but I have been informed that this did not stand the deteriorating influences of time, and the drain layer's pick.

The fall of a pole is always a misfortune and may be a disaster. In all events it is an occurrence to be avoided, and I believe that in cities it will be found a wise precaution to use wood treated by some of the antiseptic processes or to substitute tubular iron masts for wood poles, in accordance with the best American practice for supporting trolley wires.

As the objection to overhead wires is largely based upon their unsightliness, so, on the other hand, the safety of underground wires is far more an assumption than a reality. The maintenance of insulation from the earth with currents of high electro-motive force seems to be impracticable, even when the material of the conduit, as well as the covering upon the wires, is of high resistance.

In addition to the grounds on the buried wires, which may be the primary cause of difficulties elsewhere, there have been numerous destructive explosions wherever underground wires have been used. These explosions have been generally, and I believe incorrectly, ascribed to leakage of illuminating gas into the conduits. Even if there was such a leakage, there would not be any arc or undue heating of wires causing an ignition of the gas unless there was a connection to earth, and in such a case the explosions would vary in force and only be severe in case of the coincidence of a certain mixture of gas and air.

As these explosions have always been of a violent nature, we must look elsewhere for a cause which will always produce a high detonation; and this is accounted for by the presence of water in the conduit. Water being readily dissociated by electrolysis into a highly explosive mixture, an explosion would occur whenever the supply of water diminished sufficiently to produce an arc.

It is, however, undoubtedly true that gases from sewage as well as illuminating gas penetrate into conduits, and the lead covering on the insulation of wires in conduits is in some instances actively attacked from such causes.

In one city where there are numerous underground telephone wires of this class, the corrosion of the lead covering was stopped by forcing sulphureted hydrogen gas into the conduits, forming a sulphate of lead on the outside of the coating. Some of the gas escaped, causing loud calls summoning the local board of health for gross dereliction of duty, but all complaints were appeased by the gentle hand of time, which wafted the unwelcome perfume away.

It should not be forgotten that the network of wires over the cities has been of great service in robbing the lightning of its dangers, more largely by induction than by dividing the charge and conducting it to earth. It is a fact that injurious effects from lightning in cities have diminished of late years, and, notwithstanding the density of occupation by buildings, they are far less than in the country.

In the present state of the art overhead wires must be recognized as necessary for the maintenance of electrical service. The few instances where they are put underground are in accordance with peculiar conditions and scarcely numerous enough to be considered as an exception to prove the rule.

Wires should be carried well above buildings and attached to fixtures rather than directly to the buildings themselves, being placed high enough not to interfere with firemen or others passing over the roofs. They should also be clear of other wires and protected with dead guard wires whenever there is any possibility that they may fall and come in contact with other wires.

The question of the insulation of such outside wires is far from being a settled one to the extent of actual practice. The greater part of the insulating material on these wires has become so deteriorated as to present but little electrical resistance, and it is necessary to place wires in such a way that the reliance will be upon the freedom from contact with other conductors rather than upon the insulation itself.

An insulating material upon outside wires should be water proof and also able to resist the severe and almost continuous abrasion liable to come upon them, and where these wires enter buildings they should be bent in what is termed a water loop, so that the immediate approach to the building shall be upward. They should also be provided with a double pole switch capable of being operated from the outside, entirely cutting off all electrical connection with the inside of the building when so desired.

Whenever outside underground service is in use, still greater precautions are necessary at the entrance of the building. It is essential that there should not be any free opening from the cellar of the building to the conduit, and that the insulation of the wires should be maintained at this point and up to some suitable location where a double pole switch can be placed.

The greatest danger from wires outside of buildings is that due to contact with other electrical wires, imposing upon them currents of greater volume than they can withstand, and heating the various parts to such an extent that the injury is not limited to the mere fusion of the coils of such apparatus, but the surrounding combustible material is ignited.

On account of the various widely differing characteristics of these foreign currents there has not as yet been found any single device which will protect them against injury. These elements of defense have been carried to great perfection by the telephone companies.

The form of apparatus is fourfold in its nature; first the ordinary serrated lightning arrester, which is generally able to protect the system by reason of the extent to which the lightning is divided by the numerous wires in its course, and, as has been mentioned before, this lightning is very often inductive in its nature rather than a direct stroke.

Second, the telephones are protected against currents originating from incandescent lighting or power circuits by means of pieces of easily fusible wire, about four inches in length, inserted in the line of the telephone system. These wires are inclosed in glass tubes, not merely to protect them from injury, but also to prevent any damage being caused by the hot metal of the fuse igniting anything when it is thrown about by the explosive violence which occurs whenever a heavy current melts it.

A similar device consists of a strip of tinfoil rolled up with asbestos paper and forming a part of the circuit, the tinfoil being instantly vaporized by an abnormal current.

Third, for protection against the currents proceeding from arc lighting apparatus and those used for the transmission of power, particularly the overhead trolley system, the most efficient means has been the air cut-out, consisting of two pieces of gas carbon separated a very short distance by means of a thin film of mica containing perforations. One of these pieces of carbon is connected to the earth and the other forms a part of the circuit. Whenever a current on a grounded circuit, having a tension of about 350 volts, passes along the telephone circuit, it leaps the narrow space separating the two carbons, and forming a very short arc, continues to the ground. Small bits of easily fusible metal are inserted in holes in the carbon, and if the current is maintained for any particular length of time, the metal becomes melted and establishes a conductor of low resistance to the earth. A film cut-out can be used for the same purpose, but in this case is not quite so suitable because of the necessity of readjustment in every instance where it is called into operation.

Fourth, another class of accidents are those arising from a cause more difficult to manage, and that is what are known as sneak currents, being generally foreign currents connected with the system by something serving as a shunt of high resistance, so that the currents are very small, but yet enough to injure the electro-magnets, and also to cause fire when they are maintained for a long time; for it should be remembered that the insulating material upon the wires used in electrical apparatus is also a non-conductor of heat, and it is not possible for them safely to conduct as great currents as if they were not covered with insulation and were exposed to the air, allowing the heat to pass off by radiation instead of becoming cumulative.

The only form of apparatus which has thus far controlled these sneak currents is simply a ball, principally composed of wax and nearly half an inch in diameter, held against the electro-magnet by a strip of spring metal. Whenever the electro-magnet becomes warm this ball softens, and the movement of the spring operates a switch which shunts the telephonic apparatus out of circuit.

There have been a great many devices invented for the purpose of protecting telephonic circuits, but many of them involve the introduction of electro-magnets in the circuit, a measure which would interfere very much with the service on account of the impedance given to the undulating currents to an extent that would diminish the clearness of the transmission of speech by the telephone. They are frequently of such large dimensions that it would not be practical to apply them to the switchboard of any extensive central station. Moreover, it is found by experiment that these devices do not control the whole range of foreign currents liable to be met with at any instant in the telephone service.

The method which has been described, however, furnishes the most satisfactory results in actual service, being the outcome of investigations of electricians connected with the telephone companies, corporations whose interests are far greater than those of any individual, for it should be remembered that the telephone companies own all the apparatus.

The installation of conductors for arc lighting circuits inside of buildings should be made with the utmost care. The use of the high electro-motive force for arc lighting imposes conditions of insulation far more severe than those of incandescent lighting. Not only should the wires be covered with an insulation which is waterproof if there is the least danger of water or dampness reaching the wires, but wires of opposite polarity should be separated at least a foot apart.

The specifications for insulation usually require that it will not fray by friction and will stand a temperature of 150 degrees without softening, and to this should be added that the insulation shall withstand as low a temperature as it will ever be exposed to without cracking.

Whenever wires are run in places liable to dampness, reliance should not be placed on the insulation alone, but the wires should be fastened to glass or porcelain insulators, and wherever wires pass through floors, walls or partitions, they should be further protected by insulating tubing projecting on both sides. The lightning arresters should be grounded outside of the building and preferably connected to a water pipe.

Inside wiring on incandescent work also requires especial care. All parties are agreed that no wires smaller than 18 Birmingham wire gauge or 16 Brown & Sharpe should be used. These have a nominal capacity of conducting five amperes of current, but the limitation of size of wires depends on their position, as the resistance is converted into heat, and exposed wire will safely carry a greater current than when confined behind mouldings or in tubes, the ordinary ratio of practice being one and two-thirds.

No doubt some of the mishaps attending the use of underground wires have been due to the heat of the wires evaporating volatile matters in the insulating material. On shipboard such wires should be tinned before the insulation is applied, in order to prevent any tendency to corrosion. Whenever wires are laid in moulding there should be a strip at the back, in order to prevent the wire from lying against the wall.

Imbedding of wires in plaster is not generally indorsed, but improvements in insulation will render this more permissible, although in any case such wires are subject to interference caused by contraction and settlement of buildings, and, furthermore, they cannot be arranged to provide for additions and alterations to an electric plant installed in a building.

Dr. A. F. Mason recently informed me of a contract to install forty-eight and one-half miles of electric lighting wire in a building under a contract guaranteeing the wires to resist cement, lime and salts found in the materials used in the construction of fire-proof buildings, and to sustain an insulation of one million ohms for one year.

The usual methods of conducting electrical wires, to which reference has been made, are confessedly of more or less temporary character, and wholly inconsistent with the well established position of electrical illumination in its practical applications and such methods of installation are necessarily more or less obtrusive in the manner of their construction, interfering with methods of decoration.

Wires have sometimes been concealed in insulating tubing known as interior conduits. These tubes are placed out of sight in a building, comparable in arrangement to a system of gas pipes. The wires are run through these tubes by inserting a stiff steel tape with a knob at the end, which is easily pushed through any portion of the tubing. Afterward a line is drawn through, and then in turn the electric wires. These wires can be inserted or withdrawn without disturbance to the system. Such tubes, when made of incombustible waterproof material, which is a non-conductor of electricity, can safely be installed in the manner indicated, and serve a very useful purpose in widening the field of applications for electric lighting.

Fuses should be double pole, mounted on incombustible bases, and should be used whenever the diameter of the conductors changes.

Each cut-out should interrupt the passage of the current in excess of the amount to which any portion of the apparatus which it protects is adequate to transmit, and the strip of fusible metal should be marked with the current which it will transmit.

There should not be any joints or fuses or switches in rooms containing inflammable vapors or highly combustible material fine enough to float in the air.

Arc lamps should be provided with globes with tight stands, so that sparks from the carbons shall not reach combustible materials. They should also be provided with some stop which will render every assurance that the lower carbon will not fall in case the usual clamp should not secure it. In addition to the hand switch, they should also have an automatic switch, which will shunt the current around the carbons if they should fail to feed properly.

Incandescent lamps are not usually a source of hazard in themselves as directly causing a fire; yet there are some precautions to be observed, the most important being the prohibition of wrapping the lamp in paper or other material which would retain the heat, because it is possible to ignite easily combustible material in that manner. It is considered that a very serious fire once resulted from this cause.

In damp places the sockets should be rendered waterproof, and wherever there are inflammable vapors the lamps should be protected by glass receivers. When incandescent lamps are attached to gas fixtures, an insulating coupling should be inserted in the gas pipe.

In lighting vessels, when it is necessary to have lights near the compasses, the effect of the electric current on the compass should be carefully considered, and, whenever an electric wire approaches within six

feet of a compass, a wire of opposite polarity should be run parallel to it. I do not feel sure that this distance of six feet should be regarded as the minimum to which this rule should apply, and trust that the matter will receive careful investigation, on account of the importance of any question pertaining to the adjustment of compasses.

In the presence of inflammable vapors there should not be any hand switches; and, as a general rule, wherever the conditions of illumination from a number of incandescent lamps are uniform, it is frequently desirable to use a main switch to throw them in or out, although the varying conditions of load or current on the dynamo are such that it is not recommended that over fifty lights should be so connected with any one switch unless the conditions of the case are thoroughly understood and agreed upon. All switches used in the conductors of electric lighting installations, apart from those at the lamps, should be double pole, and should be mounted on incombustible bases with an indicator showing whether the switch is open or shut.

Every electric lighting plant should be provided with instruments of precision for measuring the output of the dynamo. These instruments should be placed on the switchboard in a position where they will not be affected by magnetism from the dynamo.

The conditions of the operation of electric plants generally do not admit of the use of ordinary methods of measuring the resistance of the insulation between the earth and the system, and the magneto is used as a feasible method of indicating to some extent the presence of any ground of low resistance. Although this instrument has been severely criticised, yet it fills a useful purpose within the proper limits of its service. It is portable, can be used by any one, and the indications can be relied upon within the limits of the instrument. It is far more delicate than the galvanometer of low resistance frequently used in connection with two or three cells of battery.

A magneto may not always be suited for use on extensive incandescent installations, because the static charge of the circuits is sometimes sufficient to ring the bell. A convenient method of indicating grounds of low resistance is by means of incandescent lamps placed on a conductor between the earth and the system, but such lamps should be connected with a spring switch in order that the ground may not be a permanent one.

The use of electric lighting and power apparatus is so firmly established as to render it undoubtedly one of the most permanent appliances in use, and the time is passed when temporary and makeshift methods can be tolerated.

There is a tendency toward the increased use of currents of higher electro-motive force wherever it is feasible to reach an economy of copper wire by such methods.

This tendency received a setback a few years ago by the failure of experiments attempted in France, involving the use of currents of electro-motive force of fifty thousand volts. As late as three years ago at a meeting of the National Electric Light Association, one of the members expressed the opinion that in the immediate future, currents of as high as ten thousand volts electro-motive force would be distributed. So deep was the feeling that the speaker was in error, indignation was expressed that such an opinion should be held by any one engaged in a discussion before that organization, and the president left the chair to engage in the debate and to place the seal of condemnation upon such radical ideas. It was only two years later that currents of ten thousand volts electro-motive force were actually used in some cities.

The status of the uses of electricity for illumination and power is so well established upon a practical basis, as regards the service to be expected and the character of the attendance required, that there is but little of a tentative or experimental nature in such work, and there is, therefore, no excuse for the continuance of many of the temporary methods of installation which have been in such general use.

One of the pernicious results liable to occur as a consequence of such methods of installation is the depreciation of such apparatus—from which I apprehend that difficulties may arise in the future.

Because there is much that is strange, wonderful, and unprecedented in these applications of electricity, there has been a tendency on the part of the general public to expect too much from them, both by way of advantage and of mishap. In case of fire, the press frequently ascribe the results to electrical wires purely on presumption, without any evidence to establish the fact. Furthermore, in many instances such allegations are made when the known facts or weight of presumptive evidence indicates a contrary cause. It has been fully established by the experience of the past twelve years that a well installed electric lighting plant is the safest method of illumination.

THE CHEMICAL NATURE OF SILK.*

By THOMAS WARDLE, F.C.S., F.G.S.

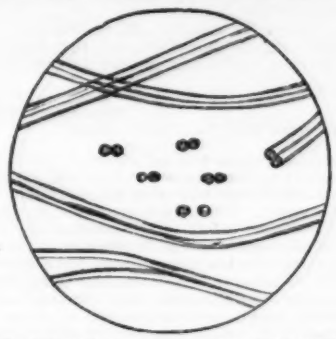
IT will add more to the interest of this subject to compare the chemical natures of both the round fiber of the *Bombyx mori* with the flat fiber of tussur silk. An analysis of tussur silk was made under the direction of Dr. Knecht, by E. Bastow and J. R. Appleyard, students of the chemistry and dyeing department of the Bradford Technical College, in 1888, which gave the following percentage results:

Carbon	47·18
Hydrogen	6·20
Nitrogen	16·85
Oxygen	29·67
	99·90

They do not state whether the analysis was made of the tussur silk of India, *Antheræa mylitta*, or that of China, the *Antheræa pernyi;* probably it was the latter, and as they differ in structure, and, no doubt, somewhat in composition, a determination of one or the other is still to be desired, and it would be interesting to see the analyses of both side by side, and also of the gum or sericin of each species.

* Extract from a paper read before the Society of Arts, and now published with the permission of Mr. Thomas Wardle of the Society.

Let me now institute comparisons between ordinary silk and tussur silk. When the raw silk of commerce (*Bombyx mori*) is heated in water under pressure, it yields two compounds, fibroin and sericin, or silk gelatine. Fibroin constitutes about 66 per cent. of raw silk; it is a silky, glistening substance, which is insoluble in water, but dissolves in strong acids, alkalies,

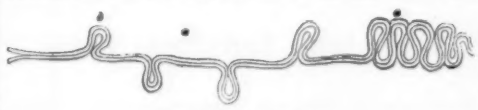


ORDINARY SILK, SHOWING TRANSVERSE SECTIONS.

and a solution of cuprammonium sulphate. When boiled with dilute sulphuric acid it yields glycocol, leucine, and tyrosine. There are two analyses of the fibroin of the silk of commerce (*Bombyx mori*), one by Mulder and the other by Schutzenberger, which are shown in the following table:

	Mulder.	Schutzenberger
Carbon	15	71
Hydrogen	23	107
Nitrogen	5	24
Oxygen	6	25

Sericin or silk gelatine has a composition of $C_{15}H_{23}N_5O_6$. It is a substance resembling gelatine. Its hot aqueous solution is precipitated by alcohol, and, after

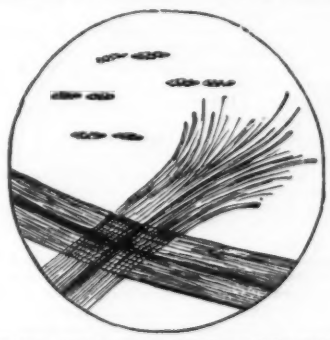


TUSSUR SILK.

(The loops at *b* are formed by the action of the gum.)

drying, the precipitate forms a colorless powder, which in cold water swells up to a gelatinous mass. On boiling it with dilute sulphuric acid it yields a small quantity of leucine, and larger quantities of tyrosine and serine, or amidoglyceric acid.

Thus the silk of the *Bombyx mori* consists of two distinct compounds, the pure fiber, which is fibroin insoluble in water or soap, and sericin or silk gelatine, which is the gum or gelatinous envelope or varnish of



TUSSUR SILK, SHOWING SEPARATED FIBRILLÆ AND TRANSVERSE SECTIONS.

the fiber. It is partially soluble in water, and entirely dissolves and separates from the fiber in a boiling soap bath. Tussur silk has also this dual composition. The following comparative table shows that tussur silk is composed of the same elements as the silk of commerce, but in other proportions.

	Tussur silk.	The ordinary silk of commerce, *Bombyx mori*.	
		Calculated for Mulder's formula $C_{15}H_{23}N_5O_6$.	Calculated for Schutzenberger's formula $C_{71}H_{107}N_{24}O_{25}$.
	Per cent.	Per cent.	Per cent.
Carbon	47·18	47·78	50·26
Hydrogen	6·30	6·23	6·31
Nitrogen	16·85	18·90	19·84
Oxygen	29·67	26·04	23·60

The difference, therefore, between the composition of ordinary silk and tussur silk is as follows: Tussur silk contains less carbon, according to Schutzenberger's percentage, which is 50·26; Mulder's percentage giving 47·78. Hydrogen is about the same in both silks; 2 to 3 per cent. less nitrogen, and about 4 to 6 per cent. more oxygen. I do not consider this difference of composition sufficient to account for the difference in the dye-absorbing qualities of the two silks, which I think depends much more upon their different physical structure, and the chemical nature of the brown coloring matter of tussur silk, not yet ascertained.

Besides this, there is the difference in the amount and nature of the gummy and gelatinous envelope secreted by the respective caterpillars around the fiber at the time of seriposition. In the *Bombyx mori* silk, the gum, or—as the French call it—*grès*, which incases the fiber as a varnish to preserve and protect it, amounts to 25 per cent. and upward in the case of China silk, and varies in other silks from 22 per cent. to 30 per cent., Bengal silk containing the largest amount. The foregoing analysis of its tussur-fibroin shows its nature. The composition of its gum or sericin has not yet been ascertained. From long experience of it I am convinced that it differs in constitution from that of the *Bombyx mori*, and there is a difference also in the sericin of the two tussur silks. It is much more soluble in hot water than *Bombyx mori* sericin, but it was best removed from the fiber by a boiling soap bath. Chinese tussur silk contains more sericin than Indian tussur, and it is generally loaded with saline and dirty extraneous matter. Indian tussur is always cleaner, and contains a higher percentage of silk.

The following table shows the reduction of weight of 1 lb. each on China and Indian tussur silks as compared with the same quantities respectively of four kinds of the ordinary silks of commerce—Italian, China, Japan, and Bengal. This is from a recent careful examination made by one of my sons for this paper:

Species of Silk.	Weight of 1lb. after washing in water at 125° F.	Percentage of loss.	Weight of 1lb. after boiling in a bath of soap.	Percentage of loss.
China tussur	15oz. 11drms.	13·7	12oz. 11drms.	21
Indian tussur	14oz. 9½drms.	9	14oz. 5drms.	11
China	15oz. 9½drms.	2½	11oz. 6drms.	27
Japan	14oz. 11½drms.	8	11oz. 2drms.	30
Italian	15oz. 5½drms.	4	11oz. 8drms.	28
Bengal	14oz. 14½drms.	6½	11oz. 3drms.	30

The soap, etc., in the manufactured thread must be considered, as the loss is not all natural.

Peroxide of hydrogen reduces a large portion of the brown coloring matter of the tussur silk, but causes a further loss of 10 per cent. The gelatinous varnish of tussur silk is undoubtedly much more soluble in water than that of ordinary silk, and a few applications of boiling water will remove it altogether. I hope shortly to examine the chemical nature of the sericin of both the tussur species.

Bastow and Appleyard found a total loss of 26·49 in boiling tussur silk with water, and afterward with soap solution. This rather points to the silk they examined being a sample of Chinese tussur, and loaded with its usual extraneous matters. I frequently find a still higher percentage of loss in Chinese tussur, occasionally as high as 45 per cent. The specific gravity they state to be 1·440. They found a high percentage of ash in raw tussur, consisting of inorganic substances, in the following proportions:

	Per cent.
Soda (Na_2O)	12·45
Potash (K_2O)	31·68
Alumina (Al_2O_3)	1·46
Lime (CaO)	13·32
Magnesia (MgO)	2·56
Phosphoric acid (P_2O_5)	6·90
Carbonic acid (CO_2)	11·14
Silica (SiO_2)	9·79
Hydrochloric acid (Cl)	2·89
Sulphuric acid (SO_3)	8 16
	100·35
Oxygen equivalent to Cl	0·65
Total	99·70

—*The Dyer and Calico Printer.*

SIMPLEX GAS GENERATOR.

By C. G. MOOR.

THIS new pattern gas generator posseses several advantages over those now in use. It may be used equally well to prepare hydrogen, carbonic acid gas, chlorine (using the compressed chloride of lime), or sulphureted hydrogen.

The last mentioned can best be prepared by using

commercial hydrochloric acid mixed with an equal bulk of water. The apparatus is easy to clean and charge, delivers a drier gas than most other forms of generator, and the liquid cannot travel up the gas tube. The parts may be had separate.

To charge, take out bell jar and unhook perforated pot, fill it with the solid and replace, pour acid into outer jar till about half full.

The solid may be any size or shape provided it is not dust. Any part of the apparatus can be had separately to replace breakages.—*Chem. News.*

PURIFICATION OF WATER BY METALLIC IRON.

By HENRY LEFFMAN, M.D.

MY purpose in the present contribution is to briefly explain and demonstrate the efficiency of a simple process of purifying water. Of the value of such process it is not necessary to speak. Not only do the requirements of sanitation demand pure water, but many manufacturing industries cannot be carried on without such supply. It will not be necessary for me to detain you with the history of the process, except to say that it originated in an effort to improve the water supply of the city of Antwerp, about six years ago, at which point the only supply available to the company which had secured the franchise was a river very turbid and impure. The success of the system on a large scale for the past six years at Antwerp, and for shorter periods, at other places, has been attested by the reports of experts and the statements of impartial observers, among the latter being a member of the State Board of Health of Pennsylvania and a member of the Board of Trade of Philadelphia. The practical process may be explained as follows:

Metallic iron in the form of either cast iron borings or steel punchings is placed in a cylinder so arranged that, by a slow rotation, the iron may be continuously showered through the water, which is being passed at moderate speed through the same cylinder. The cylinder is provided with pipes, by which air may be introduced in direct contact with the iron, if necessary. The chemical action consists in great part in the conversion of the iron into ferrous carbonate (protocarbonate of iron) through the agency of the carbonic acid, which partly dissolves in the water and partly remains suspended in the form of dark green turbidity. On exposure to the air the iron is converted into ferric hydroxide (hydrated sesquioxide of iron) which settling rapidly carries down with it and oxidizes the organic matter. The flocculent sediment permits of rapid and perfect filtration through a simple sand filter.

The process may be carried out in the laboratory in such a manner as to exhibit results as they would be obtained in the actual treatment. It has thus been possible to examine the behavior of waters of different types, and to determine the most satisfactory system of application.

A process of this kind, essentially simple, does not require for its correct presentation an elaborate discussion of the theories of the action. For evidence of its efficiency, I think I can best point to the continued successful application of it to the purification of the waters of Antwerp, Dordrecht, Paris, Nancy, and other places.

The advantages of the Anderson process, as this method is called, over other methods of purification and filtration, are, among others:

1. The avoidance of the use of chemicals.

Far from exciting prejudice, the idea of putting rusting iron in contact with drinking water is one that has been familiar to the public mind from time immemorial. Scientifically utilized, as in the Anderson process, metallic iron, by its mere contact with impure water, produces by the help of the ingredients of the waters the salt necessary to produce purification. Natural oxidation causes this salt to act as a coagulant, and further the action of the ferric oxide or rust in its nascent state furnishes the power of destroying organic matter by a process which has been likened to the burning of holes in linen by rust stains or iron mould.

2. The automatic and continuous renewal of the active surface of the iron.

By means of the revolving purifier system (the technical name for the process), the various forms of iron previously recognized as efficient purifiers of water can be utilized, without incurring the mechanical difficulties resulting from their use in filters which become choked up and caked after a short time.

The iron being in a constant state of agitation, no choking or caking together of the purifying medium is possible. The particles of the finely divided metal are kept rubbing against one another, and new surfaces are brought into contact with the water, which in its flow carries out of the cylinder the iron which has been dissolved by chemical action with the impurities contained in the water. Owing to the completeness of the contact between the iron and the water and the large surface of metal exposed, purification is effected in 3½ to 5 minutes for moderately bad water and in 5 to 16 minutes for sewage effluents.

Again, it is evident that any purifying material spread out in a filter is constantly reducing the area of its active surface, by the formation of the compounds which it makes in removing the dissolved impurities of the liquid it is filtering. The degree of purification effected must, therefore, constantly decrease until steps are taken to remove the products of the purifying action, and to revivify the purifying material. This has always been one of the greatest difficulties encountered when endeavoring to purify water or sewage, on any scale of greater magnitude than that of a laboratory experiment or of a domestic filter. The revolving purifier entirely overcomes this difficulty by the constant rubbing together of the particles of the purifying material, and the carrying away by the liquid itself of what we may generally term the products of the purification.

3. The removal of micro-organisms to such an extent that the water as delivered is practically sterile.

This extraordinary fact is conclusively proved by the experiments made at Antwerp, by Professor Van Ermengem, on samples drawn at frequent intervals from the delivery pipes of the sand filters when supplying over two million gallons per day. The one hundred thousand microbe colonies contained in a cubic centimeter of the Nethe water are reduced to an average of five colonies, which, considering the great difficulty of avoiding all contact with the air in these delicate tests, is equivalent to a complete destruction of the micro-organisms.

The observations show that the process is applicable to the purification of all classes of natural waters. Waters turbid from suspended clay or sand, or colored by vegetable matters, are especially susceptible of rapid and complete clarification by it. In all cases, chemical tests of the treated water show marked diminution in the organic matter, and the filtered water is practically sterile.

Among the numerous results, I record the following as exhibiting the effect of the process on waters of different and familiar types. For estimating the reduction of the organic matter, the acid permanganate method was used, since, although not wholly trustworthy for determining the sanitary value of a given sample, it is convenient, and suffices for comparison between various samples of the same water. The figures are in parts per million.

A sample from Wilmington, N. C., strongly colored by dissolved organic matter, but not turbid, was treated, and the oxidizable matter determined. The results were as follows:

	Before Treatment.	After Treatment.
Oxygen absorbed at 212° F.	14·20	2·44

The filtrate was clear and colorless.

The efficiency of the process in its application to turbid river waters is well shown in an experiment on the Mississippi water. This contained much suspended matter, which after many days' standing did not perfectly settle, and could not be filtered clear. Treatment in the laboratory by the iron process gave results that were most satisfactory. After shaking with the iron, and aerating by standing for a few minutes in an open vessel, the ferric hydroxide separated in large flakes, which permitted of prompt and rapid filtration, yielding a perfectly clear filtrate. To determine the degree of chemical purification, the oxidizable organic matter was determined as follows:

	Before Treatment.	After Treatment.
Oxygen absorbed at 212° F.	2·88	0·36

—*Jour. Anal. and App. Chem.*

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TABLE OF CONTENTS.

PAGE

I. BIOGRAPHY.—Professor Tyndall at Home.—A characteristic description of the life and habits of Professor Tyndall, his country home, and study, and the famous "heather screen" his portrait, with characteristic illustrations.—3 illustrations..... 13255

II. CHEMISTRY.—Purification of Water by Metallic Iron.—By HENRY LEFFMAN, M.D.—Purification of water supply by contact with agitated iron scrap, with chemical determination of the efficiency of the process, and its effect on germs and bacteria..... 13270

Simplex Gas Generator.—By C. G. MOOR.—An excellent automatic gas generator, easily charged and cleaned out, applicable for preparation of hydrogen carbonic acid gas, sulphureted hydrogen and other gases.—1 illustration..... 13269

The Chemical Nature of Silk.—By THOMAS WARDLE.—Comparison of different silks by chemical examination, round fiber and Tussur silk, with microscopic examination of the fiber.—3 illustrations..... 13269

III. DECORATIVE ART.—The Decorative Treatment of Natural Foliage.—By HUGH STANNUS.—A second of these valuable London Society of Arts lectures, treating of realism and its utilization and of the different degrees of conventionalism in art.—14 illustrations..... 13264

IV. ELECTRICITY.—Fire Hazards from Electricity.—By C. J. H. WOODBURY.—Very valuable practical notes on electric practice, with special reference to the causing of fire by electricity, with interesting examples from practice, illustrating what may cause fire, the proper care of dynamos, and instruments required in running a plant safely..... 13267

V. GUNNERY.—Gun Wrinkles.—By G. D. HISCOX.—How to examine guns.—Their care and use, with curious features of their action.—Practical recipes for coloring barrels, ornamenting stocks, etc..... 13260

VI. MISCELLANEOUS.—Merry-go-Round.—A new merry-go-round, giving vertical components of motion in addition to the regular rotation.—2 illustrations..... 13257

VII. MINING ENGINEERING.—Our Sources of Tin.—By GEORGE P. MERRILL.—The American tin ore deposits.—Their locality and prospects for their future utilization..... 13257

VIII. NAVAL ENGINEERING.—The Last Days of the Great Eastern.—Interesting views of the demolition of the famous ship.—What disposition has been made of the immense quantity of iron.—With very full notes of her history.—Remarkable success in doing the work without loss of life or limb.—4 illustrations..... 13258

The Itata.—View of the Chilian transport that attempted to carry arms to the Chilian insurgents.—The vessel which was the object of so much recent contention..... 13260

IX. PHYSIOLOGY.—Intelligent Atoms.—Prof. Edison's views on electricity and life, with the opinion of other eminent scientists and well known people on the same subjects.—A curious examination of a difficult problem..... 13251

X. TECHNOLOGY.—Cotton Seed Oil and the Products of the Cotton Seed.—By D. A. TOMPKINS.—A very exhaustive and valuable paper on this subject, giving practical information on cotton seed oil, its uses, general items of advice, with a list of the cotton seed oil mills in the South, their locality, capacity, and capitalization.. 13261

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